THURSDAY, JUNE 14, 1883

THE ECLIPSE OBSERVATIONS

THE following telegrams have been received touching the observations of the total eclipse of the sun on the 6th ult. :—

To the Secretary, Science and Art Department

SAN FRANCISCO, June 12, 8.16 A.M.

Double grating on equatorial indifferent; dense prism on 6-inch equatorial good; integrating Hilger good; red end slit good, red end prismatic camera indifferent, first order blue Rowland bad, second order blue Rowland bad, 4-inch photoheliograph indifferent, small photoheliograph good. Lines obtained mostly hydrogen, prominences almost absent.

Through Reuter's Agency

SAN FRANCISCO, June 12

The solar eclipse on the 6th ult. was very successfully observed by the English, American, and Continental astronomers stationed on Caroline Island, the sky being beautifully clear at the time. The corona extended over a distance of two diameters from the sun. The light during the middle of totality was equal to that of the full moon. Successful observations were made by Dr. Janssen, as well as by Prof. Tacchini, the intra-Mercurial planet Vulcan was not seen by M. Palisa. The D line of the spectrum was seen dark in the corona by Dr. C. S. Hastings. Good photographs of the corona were obtained by the English observers as well as by Dr. Janssen. The English observers were also successful in obtaining photographs of the flash. Good photographs were taken of the coronal spectrum in the blue end. The health of Messrs. Lawrence and Woods, the English observers, is excellent.

Putting these two telegrams together, there is every reason to be contented with the work which has been done by the polyglot band of observers on Caroline Island, for, as is to be gathered from the telegrams, this and not Flint Island was the one selected for the site of the observatories. Certainly the photographic attack has been stronger than it has ever been before; more novelties have been attempted, and more have been successfully achieved, whilst the scale on which the work has been done leaves nothing to be desired. Taking, for instance, the photographs of the corona, although we do not know the precise size to which Dr. Janssen limited himself, we may be certain that among his attempts would be included one to take pictures, giving a dark moon of at least six inches in diameter. That by means of the clockwork-driven photographic plate, the flash, by which term is meant that instantaneous appearance of bright lines at the moment of commencement and end of totality, has been secured, shows us that we have now a method of recording eclipse phenomena which is not likely to be neglected on a future occasion. We may hope in a few days' time to get some further information touching the eye-observations made by Prof. Tacchini and the American observers. Reuter's telegram is strangely silent about them at present, and there is little doubt that they have something far more important to tell us than that the dark line D was seen in the spectrum of the corona, for that was observed as long ago as 1871 by Dr. Jannsen. It would be much to be regretted if observations of the lines visible before and after totality were not attempted, especially as we learn that the photographs are limited to a greater or less extent to the lines of hydrogen.

The following general remarks have already appeared in the *Times* with regard to the results of the observations, and we cannot do better than reproduce them :—

"News from the eclipse party has at length arrived. As we stated in our article, published on the 4th of May, the American ship of war, instead of returning to Callao as was at first anticipated, proceeded to the Sandwich Islands, and there is little doubt that the English party made the voyage thence in one of the Pacific mail steamers.

"A telegram coming through Reuter's Agency informs us generally of the success of the observations. The weather seems to have been everything that could be desired, and although the observations were necessarily made from the lowest possible level, the extension of the corona was quite as great as was expected at this period of *maximum* solar activity. Further, we learn that the light during totality was quite equal in intensity to that of the full moon. This is another indication of the exceptional brightness of the corona, because in this eclipse, which was one of exceptional duration—and that is why such strenuous efforts were made to observe it—the lower and more brilliantly illuminated portions of the sun's atmosphere being more than usually veiled by the dark body of the moon during the middle of totality, the illumination of the air by these portions of the sun was less than is ordinarily the case. Unfortunately, the telegram may be read both ways touching the intra-Mercurial planet observations. We take it, however, to mean that no intra-Mercurial planet was seen by M. Palisa, who would probably give his chief attention to that point. It is satisfactory to learn that good photographs of the corona were obtained both by Dr. Janssen and the English observers. We may expect that the French photographs of the corona will surpass in beauty and detail anything which has yet been secured during eclipse observation. It is good news, too, to learn that for the first time in the history of eclipses the momentary flash of bright lines seen just before the beginning and immediately after the end of totality has been photographed. Reverting for a moment to our previous article, we would remind our readers that this end has been attained by the use of a slowly descending plate actuated by clockwork, which, since the flash has actually been photographed, will give its complete history, and enable us to determine the exact order in which the lines appeared and reappeared before and after totality.

"The telegram sent by the English observers, Messrs. Lawrence and Woods, to the Science and Art Department, supplies further particulars as to the results of the various attempts at recording the history of the eclipse. The first instrument on the official list is a Rutherford grating with 17,000 lines to the inch, which was used in conjunction with an equatorial telescope of six inches aperture. The grating was so arranged that the photographs of the green part of the first order spectrum on the one side and the same part of the second order spectrum on the other side should be attempted. This would give the region near F, one of the chief solar lines in the blue-green parts of the spectrum; but although the photographs were actually obtained, the observers do not seem to be very proud of them.

"The next instrument is a dense prism of 60°, mounted on a six-inch equatorial of very short focus. The object in view in employing a short focus was to

obtain a very small and intensely bright image of the corona, while the use of the prism of 60°, giving as small a dispersion as possible, still allowed a really useful amount to be secured. This instrument succeeded well. We do not know the number of photographs obtained by it, but if the instructions were carried out to the letter, seventeen should have been obtained.

"We come next to the instrument by means of which the photograph of the flash of bright lines to which we have referred was obtained. This on the official list is called the 'integrating Hilger.' It is a spectroscope armed with a collimator of very great focal length and directed merely to the sun's place, no image of the sun or corona, therefore, falling on its slit as is usually the case. The light from all the regions near the sun is mingled together, a photograph of the spectrum of this mixture being the special aim of the instrument. Messrs. Lawrence and Woods are evidently satisfied with the work in this direction, the code word they use indicating that they consider the results to be good ones. The moving plate with which the instrument is fitted was exposed two minutes before, and withdrawn from exposure two seconds after, totality. Knowing, therefore, as we do, that one flash was photographed, we may reasonably hope that this was the case also with the other, and as the instructions were to allow the plate to fall through one inch in eight minutes, we may also expect to get a comparison between the flash before and the flash after totality.

"The slit spectroscope armed with two prisms, which was provided by Captain Abney for the observations made last year in Egypt, was utilised also on this occasion with good results. Only one photograph was looked for from this instrument, one which would be exposed from the beginning until the end of totality.

"The prismatic camera, the instrument on the model of that used first in the eclipse of 1875, in which the corona forms its own slit, for some reason or other, does not appear to have been so successful in this eclipse, although it was tolerably so in that of last year.

"The attempt which has been least successful is that in which Prof. Rowland's concave grating was used as a prismatic camera, similar to that to which we have just referred. It was hoped to obtain a photograph of the blue end, both in the first and in the second order spectrum, but the results obtained are ciphered as bad. Seeing that Dr. Janssen was successful in his attempt to obtain large-scale photographs of the corona, we need not regret so much that our attempt to photograph it on a scale of four inches to the sun's diameter was unsuccessful.

"The small photoheliograph that was employed to such good purpose in Egypt last year has again given excellent results, which will be of the highest importance, as they will have been carefully executed, and the American party have taken no photographs themselves on the present occasion.

"The English observers telegraph that the lines obtained in the spectrum of the corona by these various methods are chiefly those of hydrogen. This, of course, does not apply to the flash we have spoken of. They add that the prominences were almost absent. This is an extremely important fact, because it shows what entire justification there was for the prediction made for the present eclipse after that of 1878, observed in the United States. That eclipse occurred at a *minimum* sunspot period, and the hydrogen lines were then seen only with difficulty, while the continuous spectrum of the corona was more or less brilliant. In the present eclipse the hydrogen lines were well seen with a very brilliant corona, as was anticipated would be the case at a period of sunspot *maximum*. This, perhaps, may explain the apparent absence of the prominences, because practically the lower part of the corona was itself made up of them.

"We have not, of course, any detailed information with regard to the results achieved by the other parties, but when our own two English observers have obtained such a rich harvest we are justified in concluding that the work of the American and French parties has been equally fruitful. In that case, the trouble which has been taken to secure the observation of this eclipse, which took place at a greater distance from home than any previously observed, will have been entirely justified.

"As we have said, the results of the other parties will take some time to reach us, but at least we may be sure of this—that the Americans, with their large experience of eclipses and their trained observers, will have much that is new and important to add to the results which our own English party has achieved."

It will be seen from what we have stated and from the extracts which we have made from the *Times* that the Royal Society and the Solar Physics Committee of the Science and Art Department are to be entirely congratulated on the result of their labours, and there is little doubt that in this, as in former eclipses, not only shall we have a most important explanation and verification of previous observations, but fresh questions will be raised to be included in future programmes. It should also be said that the indifferent success telegraphed in some cases may refer to the number of photographs taken rather than to the quality of some of them. It is not likely, for instance, that some photographs were not obtained of the bright lines before and after totality by means of the Rutherford grating, and if only two have been obtained at different epochs the greatest possible value must be attached to them.

The telegram does not state whether the observers have yet reached San Francisco, but in all probability they have, in which case they may be expected home in three weeks' time.

THE FERNS OF INDIA

Handbook to the Ferns of British India, Ceylon, and the Malay Peninsula. By Col. R. H. Beddome, F.L.S., late Conservator of Forests, Madras. Large 8vo, 500 Pages, with 300 Illustrations. (Calcutta: Thacker and Spink; London: W. Thacker and Co., 1883.)

FOR something like the last thirty years Col. Beddome has made a special study of Indian ferns under very favourable circumstances. Holding as he did till about a year ago the post of Chief Resident Conservator of the forests of the Madras presidency, he was brought into daily contact with them in his official work, and at his home at Ootacamund he formed a large collection of them under cultivation, many of which have never reached England in a living state. About 1860 he commenced his well known series of illustrations of Indian ferns, in continuation of Wight's "Icones," in which the ferns had been entirely neglected. His plates, like Wight's, were in quarto, uncoloured, and were mainly executed by native artists. His "Ferns of Southern India and Ceylon" contains plates of 271 species and varieties, and was issued in parts and finished in 1863. His "Ferns of British India," which was devoted to the species not found in the southern presidency, contains 345 plates and was finished in 1868. In 1876 he published a supplementary part, containing 45 additional plates, thus raising the total number to 660, and a revised general catalogue and summary of genera and species.

Now he has retired from his official position and come home to England, and the present work is the firstfruits of his leisure. It contains in a handy form a full description of all the Indian genera and species, and is illustrated by 300 uncoloured plates, reduced by means of photography from those of his larger books, one full page plate, with analytical details being given for each of the ninety-eight genera he adopts, and the others of smaller size interspersed amongst the letterpress. It is the first special book of portable size and moderate price which has been devoted to Indian ferns, and is in every way deserving of the extensive circulation it is sure to obtain.

India is one of the great fern-centres of the world, and it would not be an extravagant estimate to say that three-quarters of the genera and one-quarter of the whole number of ferns are known to grow within the area covered by the present work, which is precisely the same as that included in the "Flora of British India," by Sir J. D. Hooker, of which three volumes are now completed. Europe is not a rich fern-continent, and most of the European species extend their range to the Western Himalayas. The Malay Islands are very rich in ferns, and a large proportion of the Malayan species extend to the Eastern Himalayas and the mountains of the Peninsula and Ceylon; and there are in India a considerable number of endemic species. Col. Beddome deserves full credit for not making or admitting species upon insufficient grounds, and the number described in the present work does not fall far short of six hundred, all of which are Filices in the restricted sense, the Lycopodiaceæ and Rhizocarps, which would carry up the number a hundred more, not being included.

Ferns are plants that suffer very little in the drying process, and they are generally the first plants to be collected when a new country is explored. But on the other hand they are often far too large in size to be well represented in herbarium specimens, and often so extremely variable in habit, that it is very easy to mistake a mere casual variety for a genuine species. The first naming of Indian ferns on a large scale was in the great herbarium of Indian plants distributed by Wallich; but he gave no descriptions, simply names and numbers and localities, and very often confused together two or three totally different plants under the same number. In the five volumes of his "Species Filicum," the species were worked out and described by Sir William Hooker; and they were worked up again with abridged descriptions in the "Synopsis Filicum," which it fell to my lot to continue after his death. In England the other botanists who had specially attended to Indian ferns were Prof. David Don and Messrs. John Smith and Thomas Moore. So that till within a comparatively recent date no one had written upon Indian ferns who had had any chance of studying them in the field. But now the matter stands upon an entirely different footing. In 1880 Mr. C. B. Clarke, who, after working for five years at Kew on the "Flora Indica," has just returned to India, and who had paid special attention to ferns whilst collecting largely in the Himalayas, published in the first volume of the new botanical series of the *Transactions of the Linnean Society*, a revision of the North Indian species, illustrated by 36 plates; and now Col. Beddome, whose field experience has been mainly gained amongst the mountains of the Peninsula, has worked up the whole series, with a full opportunity of consulting the type-specimens of his predecessors, deposited at Kew, the Linnean Society, and the British Museum.

As regards details of generic and specific limitation of course no two authors who work independently but will vary considerably. In the matter of fern-genera systematists are divided into two parties—one regarding a difference in veining as sufficient in itself to found a genus upon, and the other maintaining substantially intact the time-honoured genera of Swartz and Willdenow, which are founded entirely on characters derived from fructification. Of the first party among modern writers, Presl, Fée, Smith, and Moore are the leading representatives; of the latter Hooker, Mettenius, and Eaton. Upon this matter I differ from Col. Beddome, and the difference amounts to wishing to use different names for perhaps half the species included in his book. Of course what he and Mr. Clarke have written about species-limitation and the distribution of the species through different parts of India will be a great accession to our knowledge; but I am rather amused to see that out of the limited number of new species which Mr. Clarke made he refuses to admit at least half; and that he totally rejects the only material innovation that Mr. Clarke proposed on the classification of our "Synopsis Filicum," the dividing of our *Asplenium umbrosum*, to establish out of part of it a new section of Asplenium, to be called Pseudallantodia, and characterised by a sausage-shaped involucre bursting irregularly. The only points on which I feel inclined to find fault with him are two. The first, that in his key to the genera he puts Hymenophylleæ under Polypodiaceæ, without taking any notice of the difference in the structure of the sporange,—but I see this is noticed in the detailed diagnosis at p. 28. It seems to me that Hymenophylleæ have excellent claims to be regarded as a distinct sub-order. The other point on which I wish to enter a decided objection is to the plan which he follows, or rather want of plan, in citing the authorities for the specific names. When he places a species under a different genus to that under which it was classified by its original describer, he moves backwards and forwards without any uniformity between four different ways of citing the authority. Sometimes he writes "*Gleichenia glauca* (Hook.)" for a plant described by Thunberg as *Polypodium glaucum*, and transferred by Hooker to Gleichenia, which is the plan usually adopted by botanists. But in many other cases he writes "*Botrychium Lunaria* (Linn. under Osmunda)" when the species was described by Linnæus as an Osmunda and transferred by Swartz to Botrychium; or "*Cyrtomium falcatum* (Sw.)" when Swartz called the plant *Aspidium falcatum* and Presl transferred it to Cyrtomium; or even "*Lastrea thelypteris* (Desv.)" for a plant published first by Linnæus as a Polypodium, transferred by Swartz to Aspidium, by Desvaux to Nephrodium, and Presl to Lastrea. And the same uncertainty vitiates his citations of books at the end of his descriptions. His citations refer to the plant, but according to the accepted usage amongst botanists they will be taken, and very often wrongly taken, as referring to the binomial name as used, so that if any one copies synonymy from the book without checking it off he will often find it leads him astray.

J. G. BAKER

OUR BOOK SHELF

Die Weich- und Schaltiere gemeinfasslich Dargestellt. Von Prof. Ed. von Martens. (Leipzig: G. Feytag; Prag: F. Tempsky, 1883.)

"CONCHOLOGY is ris!" was the pithy remark of the lamented Edward Forbes, made in his cheery way about forty years ago, when Mr. James Smith of Jordan Hill directed his attention to the arctic nature of some fossil shells in the Clyde district. Capt. Brown, however, had previously but unconsciously published the same hypothesis, which has been lately confirmed and extended by the discoveries of Messrs. Steele and Scott at Glasgow. Since the above remark was made by Forbes the study of the Mollusca has in a general point of view marvellously increased and become popularised by innumerable publications. We have now no fewer than six periodical works on the subject, English, French, Belgian, German, Italian, and American, besides four most useful manuals in English, French, German, and American. The German and latest manual, now before me, has been written by an experienced conchologist whose father (Georg von Martens) was favourably known to science nearly sixty years ago by his "Reise nach Venedig." The present author may therefore be considered an hereditary naturalist.

The manual of Prof. von Martens differs from that of Dr. Paul Fischer ("Manuel de Conchyliologie") which is in course of publication, as well as from Woodward's "Manual," in its plan and popular mode of treatment, although all these works are equally good. The present treatise on the soft or naked and shelly Mollusks forms a small octavo handbook of 327 pages, and is illustrated by 205 figures. The principal contents of the work are as follows:—

(1) Names and position in zoology; (2) The shell in general; (3) Organic structure of the Mollusca; (4) Cephalopods; (5) Univalve shells, Nudibranchs, Heteropoda, Pteropoda, and Solenoconchia; (6) Bivalves; (7) Habitat and geographical distribution; (8) Enemies and use of the Mollusca. The illustrations are excellent; they are not arranged in plates, as in the manuals of Woodward and Fischer, but are dispersed throughout the work in their appropriate places by way of explanation. This is in some respects an improvement, although it causes an unnecessary repetition of the same figures. For instance *Margaritana margaritifera* (why not *Unio margaritifer?*) is figured three times in pp. 196, 221, and 311.

The curious varieties or monstrosities of *Planorbis multiformis*, a tertiary shell from Steinheim, are well shown in Fig. 128. I am very glad to see that the author is by no means addicted to an excessive multiplication of genera and species, which is the normal failing of so many Continental conchologists, especially in the land and freshwater shells. In the Pteropoda he has rightly adopted Pallas's generic name *Clione* (1767-1774) for *C. borealis*, instead of Müller's name *Clio* (1776), which Fischer has used in the reverse sense. *Clio* of Linné (founded on Browne's genus and Jamaican species) is wrongly represented in the manuals of Fischer and von Martens by *Cleodora* of Lamarck. As no review or notice of any book is regarded as complete or satisfactory without a dash of criticism, however slight, I would venture to suggest a few corrigenda for the next edition. It is impossible to distinguish *Helix hortensis* from *H. nemoralis*, except as a variety, the former being more northern and the latter more southern in geographical distribution. *Hyalæa* of Lamarck (1810) ought to be *Cavolina* of Gioeni (1783) and Abildgaard (1791), not of Bruguière (1792); *Loripes* is not a synonym of *Lucina*, but a distinct genus, and *Sphærium* is a much older name than *Cyclas*. But I make these few remarks more for the consideration of the author than from any pretence on my part to be a judge. I can heartily and conscientiously recommend this manual not only to the scientific but to the ordinary class of readers. J. GWYN JEFFREYS

Notes on Qualitative Analysis, Concise and Explanatory. By H. G. H. Fenton. (Cambridge University Press, 1883.)

THESE are ordinary tables of reactions of the "more common metals and acids," and also of some of the "more common organic bodies." The organic bodies include carbohydrates and a few alkaloids.

It is very strange that the farce of common and rare elements is still maintained in nearly all the tables and books on qualitative analysis. Surely such elements as titanium and tungsten and molybdenum and selenium or lithium are common enough, at any rate in laboratories, to have a place given to them in analysis books, not to mention thallium, glucinum, and cerium, which do occur in minerals, to the no small mystification of the poor student crammed up with tables of analyses of "common metals." There are rather too many empty pages in these "Notes," and the size is inconveniently large for working with on a laboratory bench.

Practical Chemistry, with Notes and Questions on Theoretical Chemistry. By William Ripper, Science Master, Sheffield Board School. (London: Isbister, 1883.)

THESE notes and questions, mostly questions, have been, as the author explains, compiled to prepare students and teachers for the examinations of the Science and Art Department. It is to be regretted that such books are required, for although, as the author states in his preface, the arrangement may have been very successful in "passing" students, it is questionable whether the information and knowledge obtained are of such a nature as to be valuable afterwards. The book is well adapted for its purpose, that of cramming.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Matter of Space

WILL you permit me to express my thanks to Prof. Herschel for his flattering review of my paper on "The Matter of Space," in NATURE, vol. xxvii. p. 349? It is certainly gratifying to find that the views which I deduced from the ordinary relations of moving matter are confirmed by the results of mathematical analysis, and it is a source of satisfaction to me to have called forth such a studied and thorough treatment of the subject as Prof. Herschel has given it. I cannot but retain my view of the unity in character of all substance, to which he objects, yet in that respect our opinions diverge but slightly, since I replace ether with excessively disintegrated matter, and he considers the particles of ponderable matter to consist of aggregates of ethereal substance. An ether whose condensation yields particled matter answers all the requirements of unity of substance.

As the subject is under discussion, there are some further points in the motor relations of particles which it may be well to indicate. It is highly improbable that the molecules of matter, even if it be in the state of a rare gas, wander at will, constantly changing their relations of position to other molecules. More probably there is very little independent change of place, each molecule being usually held as a close prisoner in a nest of surrounding molecules. The grouping of molecules may be changed by the action of external agencies, but a new molecular equilibrium tends to be quickly established. Such seems the general tendency of nature. If some of the molecules in a mass of substance have an independent motion, friction soon disseminates that motion, and brings them into harmonious conformity with

their fellows. This we know to be the case with all moving masses of matter. Their independent motion is gradually overcome by friction, and their motion brought into accordance with that of surrounding masses. The same principle applies to molecules. Friction, or molecular impact, its equivalent, must quickly reduce their discordant movements, and bring all the molecules of a mass into harmonious motor relations.

Molecules are related to their fellows in three distinct methods, those of the solid, the liquid, and the gas. We can only conjecture the character of these relations. In the solid there is perhaps no impact of molecules under normal conditions. Each molecule may lie in the centre of a nest of attractions, within which it describes a vibratory movement, without coming into contact with any of the similarly moving molecules that surround it. In the gas attraction also acts, but not vigorously enough to restrain the moving molecule, and cause vibration. Here, then, impact is incessant. Yet the molecule can seldom escape from its nest. It is driven backwards on all sides, and held captive within a contracted space. A certain harmony must arise between the motions of these gas molecules under conditions of equalised temperature, which must tend to produce an equal resistance to escape in every direction, and to confine each within a fixed space in relation to those surrounding. Such is not the case when in one gas a volume of a different gas is set free. The molecules, moving with different speeds, cannot harmonise in their impacts. The molecules of the second gas find open spaces in the net of the first, and rapidly disseminate themselves. But the probability continues that in every homogeneous gas, at a fixed temperature, there is little or no free excursion of molecules. In the liquid there are also probably harmonious relations of molecular motion. The character of this motion we do not know. It is possibly a rotation around general centres of gravity. However that be, each molecule must, under homogeneous conditions, move within fixed limits.

If such be the case, each molecule of a homogeneous mass occupies a fixed field, from which it cannot of itself escape, and whose boundaries it cannot change. These boundaries are absolutely fixed by two energies. One of these is the momentum of the molecule, by which it drives back those surrounding it. The other is the pressure bearing upon the mass of which it forms a part. This pressure is usually very great, so that the space occupied by each molecule is very minute, and its change of direction is necessarily very frequent. The pressure constitutes a tension, to which every molecule is subjected, and each has a normal rate of vibration, in accordance with this tension. Of course the weight of the molecule is a constant element in determining its vibratory pitch, which is therefore dependent upon the fixed element of weight and the varying element of pressure.

Such may be the condition of equilibrium of all material molecules, whatever their state of aggregation, namely, the confinement of each molecule within a limited field, within which it incessantly moves, but from which it cannot escape. And to this condition of absolute localisation of every particle all matter tends to come, according to the theory of dissipation of energy. But as nature now exists there are opposing influences which constantly overcome the tendency to localisation. One of these is the attraction of gravitation, which causes independent motion both in masses and in molecules. The other is the heterogeneity of momentum of molecules, or what is usually known as inequality of temperature.

So far as the first of these is concerned, matter is now nearly in equilibrium. The spheres are yet contracting, under the influence of gravity, but this contraction is so gradual as not to materially affect the relations of molecules. Their mutual localisation is but slightly disturbed by this cause. The inequality of temperature is a more vigorous disturbing cause. To this are chiefly due those transfers of energy through space, and of matter through other matter to which all life and activity must be ascribed. The inequality here referred to, as mentioned in my former paper, is not of absolute heat contents, but of temperature, which is a very different thing, since density affects the heat-containing powers of matter, and two masses of different density may be equal in temperature while very unlike in heat contents.

The accepted view of radiation is that there is everywhere an unceasing outward transfer of molecular motion, that each molecule constantly yields and constantly receives radiant heat, changing in temperature when these transfers are unequal, but not when they are equal. This seems to me an incorrect view of the subject. If two masses of matter of equal temperature be in contact there can be no radiation at all, instead of a double radiation. For no molecule can transfer any of its energy to others. If two molecules of equal momentum come into contact, neither can lose nor gain momentum. The momentum of each remains the same after as before the contact, and there cannot properly be said to have been a mutual transfer of energies. The only change that takes place is a change of direction of motion, and in this respect the change in the one case balances that in the other.

Thus properly we can speak of a transfer of motor energy only when the momentums of the molecules differ, and in this case the transfer is from the most to the least vigorous only. Heat is yielded outwardly, but not cold. This transfer is continually taking place, since the temperature of matter is very far from a state of equilibrium. The transfer takes place in two methods. One of these is through direct collision. The other is through vibratory impulse. We must consider these in succession.

Collision constantly takes place between the molecules of gases. It takes place also in solids and liquids when by any cause their molecular equilibrium is disturbed. The result of a transfer of energy in this manner is what we may call an impact radiation. Motion cannot lose or gain speed or change in direction except through the influence of counteracting energies. Thus every impact radiation must run directly outward until overcome by opposing energies of equal vigour. It is transferred from particle to particle, its speed changing in accordance with the weight of the particles, but its momentum continuing unchanged. Such impulses are constantly travelling in all directions. They are very frequently checked by equal opposite impulses, and thus become local motion of molecules. This is the ever-acting equilibriating tendency.

The other mode of molecular transfer is that supposed to be through exchange of vibrations—the radiation of light and heat. This transfer presents two relations. One is that of speed. This depends not on the speed of the motion, as in impact transfer, but on the tension of the conveying particles. As their tension increases, the radiant wave is conveyed more rapidly. As it diminishes, the wave travels more slowly. It is quite possible, indeed, that the waves of light may move with a different speed in interastral space from their known rapidity in the ether of the solar system, since ether may not be everywhere in the same state of tension. If so, certain astronomical conceptions would be affected. This equal speed of radiant transfer, whatever the rapidity of the vibration, indicates that radiance differs essentially from impact transfer. In fact, there is no special necessity in their character that transverse vibrations should be transferred. They may cease with any particle, and continue to exist as continuous vibration of that particle, or the energy of the vibration be yielded to it as direct motion. If in this case the particle move more vigorously than those surrounding, the vibratory transfer will be replaced by impact transfer.

This cessation of radiant transfer is constantly taking place. Every wave of light and heat that comes to the earth's surface is partly converted into local heat, partly transmitted through transparent substances and partly repelled from the surfaces of substances. Thus radiant transfer seems to be rather an accident than a necessity of matter, since the energy thus transferred can be immediately exchanged into local energy, without the agency of equal opposing energy, as in impact transfer. Whether the wave shall travel onwards, be absorbed, or be repelled, appears to depend on the tension of the substance which it affects. Each molecule of every mass has its normal pitch of vibration, in accordance with its weight and tension. If the radiant vibration be in complete accord with that pitch it will be retained as local heat vibration. If in imperfect accord it will be partly held. If discordant it will be transferred or repelled. In the latter case it probably follows the easiest channel. Although the direction of the ray is readily changed, yet probably it has a special vigour of movement in the direct channel. Other things being equal, it would follow the direct in preference to the reflected course. Therefore in cases of reflection there must be a resistance in the molecules of the reflecting substance which makes it easier for the wave to change its direction than to force itself on these molecules. This change of direction in the wave, however, is not a change in the direction of motion. The vibration continues in its original plane. It can only be changed from this plane by special influences within transparent substances, in which the wave vibrations, while acting upon the molecules of the substance, are in some way distorted by their interaction with the normal molecular motions.

There are two other methods of transfer of molecular motion to which brief allusion may be made. One of these is the electric transfer. The character of this we do not know, but we have reason to believe that it is vibratory, and that it bears certain analogies to light vibration. The other method is heat conduction. This is a transfer of energy by exchange of normal vibrations. It takes the place in solids of the impact transfer in gases. The molecule of the solid, when possessed of excess motive energy, cannot yield it to others by impact, and must therefore do so by a drag upon these others through the ties of attraction. This is the slowest of all modes of transfer of energy. For its proper action it is necessary that the substance should be homogeneous, and the vibrations of its molecules normal. The instant the tension changes, either by connection of unlike substances or a condensing twist in a homogeneous substance, the mode of transfer changes. The heat vibration of the molecule is offered to another of different pitch, which refuses to receive it as normal vibration, and at once the rapid electric transfer manifests itself. Normal heat vibration is thus converted into thermoelectricity.

Their brief review may help to give some idea of the relations between molecules. In their state of normal equilibrium, which they seek to regain after every excursion, they possess no independence of movement, but are rigidly confined within fixed limits. They may change place in common with all the molecules of the mass to which they belong, but not independently. Vigorous disturbing influences may break up the molecular grouping, but immediately a new stable grouping is assumed. The incessant molecular disturbances which occur do not usually cause a change of grouping. These consist of vibratory transmissions of energy, and of transfers of motion through impact of molecules, and their effect is but the production of momentary variations in the direction and vigour of the motion of the affected molecule. To the influences of this character above mentioned may be added those of the vibrations of sound, of magnetic energy, and of chemical affinity. The latter alone produces any marked variations of molecular grouping.

Philadelphia, U.S. CHARLES MORRIS

On the Morphology of the Pitcher of "Cephalotus follicularis"

I OBSERVE that the last sentence but one of my brief notice of Cephalotus, which appeared in NATURE last week, is calculated to convey an erroneous impression. The lid *g* of Fig. 1 is seen to be a conical structure with a relatively broad base and a narrower indented apex. In the matured pitcher the free portion of the lid is much broader than its more contracted base; and the developed and involuted margin referred to extends round the mouth of the pitcher *until it reaches that base, but does not cross it*, as by an oversight on my part my words imply.

Fallowfield, Manchester, June 8 W. C. WILLIAMSON

A Large Meteor

THE meteor seen by Mr. Hall of Shoreham (NATURE, vol. xxviii. p. 126) was also observed by Mr. James Cullen of the Stonyhurst Observatory. Its path, as seen from here, was from S.E. by E. to N.E. by E. (true), traversing an arc of about 70°. Its altitude was not more than from 12° to 15° above the horizon. It travelled exceedingly slowly, was visible for about 20 seconds, and was first seen at 10.30 p.m. G.M.T. Its size was that of the full moon, white in colour, and with a tail 10° to 12° in length. It burst into a shower of small pieces before it disappeared, presenting exactly the appearance described by your correspondent.

Owing to the twilight and to the haze which hung about the horizon, its position could not be referred to the stars, the only star visible being α Aquilæ, near which the meteor passed. From the compass bearings and altitude given above its approximate path was from Æ 18h. 50m., $\delta - 2°$, to Æ 22h. 35m., $\delta + 25°$.

Stonyhurst Observatory S. J. PERRY

YOUR correspondent, A. Hall, in your issue of June 7, records the appearance of a large meteor seen by him at Shoreham, Kent, on Sunday evening, June 3, at 10.40. I recorded the same meteor in the *Newcastle Daily Journal* as follows:—

"*An Enormous Meteor.*—Mr. Barkas informs us that on Sunday evening, June 3, at 10.40, an enormous meteor of great brilliancy moved slowly across the heavens from south to north, at an elevation of 30 degrees, and nearly horizontally. The colour was bright white, the apparent length 5 degrees; it had the form of an artist's brush; and the handle broke into many fragments. The head suddenly disappeared. This meteor was seen at Newcastle, Wreckington, and Cullercoats, and it would be interesting to know in what position it was observed at points far south of Northumberland."

Your correspondent does not say whether he saw it towards the south or north, nor does he state its elevation above the horizon. It would be interesting to know its apparent elevation at places north of Kent and south of Northumberland.

Newcastle-on-Tyne, June 8 T. P. BARKAS

Intelligence in Animals

IN NATURE (vol. xxviii. p. 82) is a letter headed "Intelligence in a Dog," which certainly shows that a power of reflection is sometimes possessed by the canine species far beyond what one ordinarily observes in them. Perhaps the following anecdote will interest some of your readers, in which it will be seen that the common crow of India exhibits (occasionally at least) an equal amount of a quality superior to what is usually styled *instinct* in animals.

In the summer of 1878, when I and a friend were travelling in the Himalayas, we marched from Dharmsala to Simla, passing through the native states of Mundi, Suket, Bilaspur, and Erki. One day, when we were about half way between Suket and Bilaspur, we rested two or three hours under the shadow of a rock whence there issued a spring of water most welcome to us thirsty and somewhat weary travellers. We drank our fill and threw ourselves down upon the ground. After we had been there a short time an old crow and its half-grown young one came also to slake their thirst. I happened to have a small piece of a stale chuppati (or unleavened bread which the natives eat) in my pocket, and I threw it to them; the old bird examined it, turned it over, and then called her young one to come and partake of it. The latter did his best to obey his parent, but the morsel was so hard and dry he could not manage to eat it, and said so in his own bird language. The old bird then as plainly replied "try again," which he did most obediently, but with no better success. The old bird then took up the rejected piece and deliberately placed it in one of the little streams formed by the water of the spring (perhaps about six feet beneath where I was lying); she then hopped off, followed by her young one, and here comes the most curious part of the story: in about a quarter of an hour or so both birds returned to this spot, the old one with her beak pointed to the piece of chuppati, which by that time had been rendered soft by the action of the water, and by signs and sounds seemed plainly to tell her young one, "There now, the food is soft; eat it, and no more nonsense." This the young bird immediately did.

Copenhagen, June 8 COSMOPOLITAN

MY big black Newfoundland retriever, "Faust," has a chivalrous habit of taking smaller and weaker dogs under his protection, and about two years ago he constituted himself champion of a wretched little thoroughbred mongrel whom we called the "Pauper," because it lived on charity in the garden opposite our house. "Faust" goes out marketing with the housekeeper, and as he has a passion for bread the baker's children always give him a stale roll. One day, for fun, they gave him two, which he picked up with some difficulty and then left the shop, followed by some of the children, one a lad of sixteen. "Faust" walked along the side of the garden railing till he met his pauper friend, to whom he gave one roll, and then ate the other himself, waving his tail vigorously in evident satisfaction. A neighbour of ours has a kitchen cat who was taken in out of charity himself, and who has several times brought in famishing friends for a meal. NELLIE MACLAGAN

Edinburgh, June 11

EASTERN ASIA AT THE FISHERIES EXHIBITION

THE sections of the Fisheries Exhibition devoted to China, Japan, and the British settlements and protected native states in the Malay Peninsula, are in some respects disappointing. The interest and beauty of the Chinese section are indeed unsurpassed; but the other

sections fall far below what might have been anticipated. At the Fisheries Exhibition in Berlin three years ago, Japan was excellently represented; and when we recollect that fish forms one of the principal—probably next to rice and millet, *the* principal—staples of Japanese food, that the fishing-grounds extend from the most northern Kuriles almost within the Arctic circle, through various zones down to the most southern islands of the Loochoo archipelago, where they approach the sub-tropical regions, and that the primitive methods of catching and preserving fish of more than one race are now daily practised in various parts of this chain of islands, known as the Japanese Empire, it will be seen what scope the Japanese authorities had to make their section of much practical and scientific interest. At Berlin their section did possess such interest, and the collection formed for exhibition there has, we believe, been made the nucleus for a domestic and permanent Fisheries Exhibition in Tokio. Failing the time or funds necessary to make a representative collection for London this year, it was open to the Japanese Government to take a single portion of their vast fishing-grounds—such as Yezo, or the Inland Sea, or the Loochoo Archipelago—and represent that only. This has been done by China with marked success. As it is, Japan is represented in the small space allotted to her by specimens of the fish tinned at the Government canning establishments at Sapporo in Yezo, and by a stall full of pictures on silk, lacquer, &c., of fish and fishing. These latter are all marked, "For sale at the close of the Exhibition." Doubtless the Japanese authorities had good reasons of their own for thus limiting their participation in the present Exhibition; still it is permissible to express regret that they did not add, as they undoubtedly could have done, more to its value and interest.

In the Malay States and the Straits Settlements fish is not such a staple of food as in Japan, and they are on the whole fairly represented. The curious Malay method of catching fish by constructing long and labyrinthine bamboo and cane fences, wide at the beginning and narrowing towards the end, where the fisherman's hut is placed aloft, is represented by two or three models. These long fences, sometimes stretching far out to sea, are familiar objects to every traveller in the Straits. They are protected by stringent local ordinances, and woe betide the unskilful shipmaster who runs his vessel through them.

The Chinese section, viewed from a popular standpoint, is certainly a success. No pains appear to have been spared to make it representative of the Celestial Empire in its decoration. The Chinese ambassador himself has contributed two scrolls in large characters containing verses of poetry. To the staff of the Imperial Customs under Sir Robert Hart—foremost in all that is for the welfare and good name of China—belongs the credit of this section. It would of course be impossible to represent in a single foreign contribution the fisheries of China, extending over more than 2000 miles of coast line, as well as many thousands of miles of rivers and canals, and accordingly it was decided to represent thoroughly one portion of the coast. At Berlin the Ningpo fisheries were so represented, and for this year, Swatow, a treaty port on a large estuary a little to the north of Canton, was selected. The nets, boats, lines, traps, and other implements used in fishing here, the dresses of the fishermen at various seasons, models of their huts, and a scientific classification of the fish caught in this district, form the bulk of the Chinese exhibits. In addition to Swatow, an attempt has been made also to represent Ichang, a port on the Yang-tsze, situated about 1000 miles from the sea, as well as the fisheries of South Formosa and the neighbouring islands. The collections were evidently made and catalogued in China and arranged here by experienced hands. The special catalogue published by the order of Sir Robert Hart forms a complete descriptive guide to the whole, and is most interesting and instructive. Speaking generally, it may be said that the observer is most struck in this section with the extraordinary ingenuity displayed in utilising the most ordinary and unpromising objects for the purpose of fishing. Thus in Swatow they employ a boat drawing a few inches of water, with the rail nearly level with the surface. A narrow plank fixed along one side is painted white, and the light of the moon falling on it causes the fish to mistake it for water. They jump over the plank into the boat, where they get entangled in moss or grass. At Ichang, a wild animal such as the otter is trained, not to catch fish, but to frighten them into the net; while at Ningpo, cormorants are regularly and systematically trained to fish. These and many other devices shown at the Exhibition mark the Chinese as the most ingenious and accomplished fishermen in the world. A large collection of corals, of crustaceans, mollusks, and other fish will attract the scientific observer, who will be much assisted in his examination by the special catalogue before mentioned.

NOTE ON THE INFLUENCE OF HIGH TEMPERATURE ON THE ELECTRICAL RESISTANCE OF THE HUMAN BODY

THE experiments which I have now for some years been carrying out as to the various forms of medical electricity have begun to furnish trustworthy results. Some of these, with the help of De Kilner, were incorporated in a paper read before the Society of Telegraph Engineers on March 9, 1882. We there stated that at present "we are hardly in a position to say how far the resistance of the body varies in health; but in disease it can be fairly stated that it sometimes diminishes and sometimes augments." Of this fact we gave illustrations.

It had often occurred to me that the temperature of the human body very probably influences its resistance; and some experiments had been made with a view of testing the amount of such influence. But in pathological researches it is often difficult to find a case not open to exception, and it is frequently necessary to wait a considerable time before, in the impossibility of experiment, accident presents one possessing the necessary conditions. Such a case I have now met with, and it is worth while to place it on record, if only to enable other observers to prosecute this line of investigation.

The patient is a young and intelligent gunsmith aged twenty-two. He had rheumatic fever severely twelve years ago, which, as is usual in young subjects, has left permanent heart disease behind it. This did not, however, prevent his following his trade until the beginning of April in the present year. He then began to suffer from morning rigors, occurring at first at the interval of from seven to ten days, but, since Easter, daily. He came into my ward in St. Thomas's Hospital on April 28. It is not necessary to detail the medical history of the case in a scientific periodical; it will be sufficient to state that about 8.30 a.m. he was in the habit of suffering from severe attacks not unlike those of ague, in the course of which the temperature rapidly rose to 105° F. In the afternoon it sank to the normal human temperature of 98° or 99° F. The cause of this remarkable symptom is still somewhat obscure; it has completely resisted the action of quinine and other antiperiodics, as well as salicylic acid, aconite, and other approved lowerers of temperature. It is probably due to ulcerative endocarditis slowly advancing. The most remarkable part of the case is that it causes the patient no suffering or inconvenience whatever. His mind is clear, and, except the feeling of chilliness during the period of heat, he makes no complaint. He is able to take interest in the determinations which I proceed to give.

It occurred to me that this unusual range of daily tem-

perature (7 F.) afforded the opportunity I had long been seeking. But it was some time before I could arrange suitable apparatus for its examination. A hospital ward is an awkward place for Wheatstone's bridge and delicate galvanometers. Moreover I had before found that from the peculiar conditions of the human body, the testing current, to produce accurate results, requires to be frequently reversed, for fear of opposition currents of polarisation. I am glad to see a confirmation of this observation in a verbal communication of Prof. Rosenthal to the Physiological Society of Berlin on April 13.

It was partly to overcome this difficulty that I devised, at Mr. Preece's suggestion, a dynamometer for alternating currents, of which the general arrangement was described in NATURE some time ago. It was also brought before the Physical Society at their June meeting in Oxford. Although severely criticised by some members of that learned body, it works extremely well, and may be, I hope, an addition to medico-electrical appliances. For the purpose of the present experiment I found that an ordinarily sensitive galvanometer, considerably damped by air-resistance, was sufficient, since by the zero methods of balancing, it is only necessary just to see the deflection before commutating; when balance is obtained, commutation has no effect on the needle of the bridge.

It would require more space than could probably be here afforded to give all details of the experiments, which, moreover, by the courtesy of Capt. Douglas Galton, I hope to bring before the British Association of this autumn. But a brief summary of results is as follows:—

On June 5 I reached the ward at 9.40 a.m. The rigor had begun at 8.30 and was beginning to decline; I had time, however, for the following determinations:—

9.40 ...	R. 4140	ohms.
9.55 ...	,, 3470	,,
10.10 ...	,, 2900	,,

These measurements were taken with a very small E.M.F. of about 9 volts. On June 9 I succeeded in reaching the ward during the beginning of the rigor, and took the following measurements, this time with corresponding temperatures:—

10.30 a.m. ...	Temp. 102°·4 ...	R. 4550
10.40 ,, ...	,, 104°·2 ...	,, 4630
10.50 ,, ...	,, 104°·2 ...	,, 4930

At this point the rigor, temperature, and resistance began to descend. I visited the patient again at

2·15 p.m. ...	Temp. 103° ...	R. 2300

The apparatus in these observations was left untouched, so as to prevent any accidental change. The measurement was made with a double E.M.F. to those preceding, namely, 18 volts. I determined on each occasion the resistance of the leads and terminals, which I found to be on each occasion 2 ohms.

I cannot help thinking that the difference, which is as nearly as possible twice the smaller amount, is too great to be accounted for by any instrumental error, and that the human body, in spite of its large amount of liquid constituents, follows a similar thermal law of resistance to that influencing solid conductors, though in a very much higher ratio.

Only one other point requires comment, namely, the mode of making contact between the body and the testing apparatus. Prof. Rosenthal in the communication quoted above draws attention to the high insulating powers of the epidermis. In the above experiment I passed the current through the two legs, from one foot to the other, in alternate directions. The feet were previously soaked in salt and water; two large pans containing about a quart of brine each were then placed under the feet, and in each was immersed a plate of copper five inches square connected with the bridge by stout cables. I have found in other experiments that after half an hour the resistance ceases to decrease, and in this experiment it actually increased to the amount of 480 ohms. The whole foot was immersed, its sole resting directly on the copper plate. I have two other methods of making contact in use. The first consists of rubbing the skin with the oleate of mercury; which to the diffusion power of oleic acid adds the conductivity of its base, and then immersing the part in metallic mercury. The other consists of inserting small silver claw-forceps, known to surgeons as "serrefines," through the epidermis into the tissue below. This is rather painful, but not more so than I find medical students eager in the pursuit of knowledge can and will easily undergo.

W. H. STONE

THE AMBER FLORA[1]

THIS is the first volume of a work on the flora of the amber-bearing formations of East Prussia, and is devoted exclusively to Coniferæ. The introduction contains a sketch of the geological history of the order, and among much that is of interest we find an estimate that the existing Coniferæ occupy an area of about 3,000,000 square miles (500,000 German). The described fossil species are now almost as numerous as the living (400 to 450), though a revision might reduce their number by one-half. The colossal dimensions of some of the living Coniferæ are familiar to most, but it is not generally known how nearly these are rivalled by fossil species. Examples are given, as of a stem of *Cupressinoxylon ponderosum*, broken at both ends and 200 feet long, and another 12 to 14 feet across; a stem of Araucarites, 25 feet in circumference, and a silicified stem from California, 33 feet round the butt.

A considerable portion of the work is occupied with a minute and splendidly illustrated inquiry into and description of the microscopic structure of the tissue of existing and fossil Coniferæ, especially with regard to their resin-secreting organs. Goeppert claims to have originated this study forty years ago, and is certainly the chief authority in it. The result of his work shows that the Abietineæ, or fir tribe, have almost alone contributed the amber, and that at least six species produced it, the chief being close allies of the Common Spruce and the American *Pinus strobus*. These possess three separate sets of resin-producing organs chiefly situated in the cambium layers, which are in the form of cells and ducts running in both horizontal and vertical directions, and appearing at a very early stage of growth. Some Pines are liable to frost-cracks, and into these the resin collects and thence exudes, keeping the wound from healing and furnishing a perpetual supply. Very few specimens of amberwood preserve the bark layers with the resiniferous organs, but sufficient is seen to prove that these in no way differed from those of the Abietineæ at the present day, especially of the Spruce.

The most important section of the work probably is the research into the microscopic structure of the wood, which is, however, of an extremely technical nature. Five separate species of *Pinus* are recognised by their wood, and a very rare and doubtful wood-structure is referred to the Taxineæ.

More interesting perhaps to the general reader are the descriptions of fragments of foliage and fructification inclosed in the amber. Insignificant as the figured specimens appear, they are yet in so marvellous a state of preservation that their texture and microscopic structure, and even the glaucous colouring of the under sides of some of the leaves are visible. Twenty species are determined, with a tendency, it is pleasing to find, rather to curtail than to multiply the number previously described. They have been studied with extraordinary care, and the results are consequently unusually satisfactory.

[1] "Die Flora des Bernsteins." R. Goeppert and A. Menge, Naturforschenden Gesellschaft in Danzig. 4to, 1883.

The ABIETINEÆ are represented by 2 *Pines* of the *Tæda* and 2 of the *Pinaster* section, and by 2 *Firs*. It is impossible, with the material, to more than guess at the affinities of the fossil with the existing species in such an immense tribe, but 3 are compared with American, and 1 with a European species. The presence of 2 species of the *Parasol Fir* of Japan is of especial interest, if the appearance of a double midrib on the back of the leaf is a reliable character, but a doubt seems to be expressed in the altered termination of the name, "*Sciadopites*." Nearly all the rest are CUPRESSINEÆ, and many are represented by catkins and foliage. The *Widdringtonias*, a section of *Callitris* confined to the Cape and Madagascar, are represented by 2 species. The almost ubiquitous Tertiary *Libocedrus salicornioides*, allied to the Chilian Incense Cedar, is indisputably present, even its glaucous colour being preserved. Two *Thuyas* are indistinguishable from the Chinese and the American Arbor-Vitæ, and a more doubtful form is nearly related to the *Thuyopsis dolabrata* of Japan. A male catkin exactly resembling that of the Red Cedar of Virginia (from which pencils are made) represents the Junipers, and this extraordinary assemblage is completed by the presence of the common European *Cupressus*. The TAXODIEÆ, again, are represented by *Sequoia Langsdorfii*, a widespread and somewhat northern Tertiary Conifer, closely allied to the Californian Red Wood; *Taxodium distichum*, the Deciduous Swamp or Bald Cypress of Virginia, and the well-known Tertiary, *Glyptostrobus*, all but indistinguishable from the living Chinese species. The last described is an American type of *Ephedra*, or Jointed Fir.

A group of Coniferæ must therefore have existed in Europe, almost on one spot, comprising representatives from nearly every Geographical Province. There were present such magnificent representatives of the Californian Coniferæ as the Red Wood, the Sugar Pine, the Douglas Spruce, the scarcely less majestic Bald Cypress, Red Cedar, Thyua, and *Pinus rigida* of more eastern States, the Chilian Incense Cedar, the Parasol Fir, the Arbor-Vitæ, the *Glyptostrobus*, and the *Thuyopsis* of the Eastern Coasts of Asia, the Scotch Fir, the Spruce and the Cypress of Europe, and the Callitris of Southern Africa. Based on the careful research of a man who has made Coniferæ his especial study for fifty years, these determinations have a value which the haphazard methods of so many workers in Fossil Botany do not possess. The causes which led to the dispersion and extinction in Europe, in such relatively recent times, of so considerable a group of Coniferæ would be interesting to tracc out.

The similarity between the Amber Flora and the overlying Brown-coal Flora, described by Heer, lead to the inference that its age must be Middle Miocene. The deposits are uniformly sand, clay, and loam, in which are imbedded partly rolled stones of various kinds and sizes. The whole belongs to a vast and widely spread amber-bearing "diluvial formation" which stretches from the confines of the White Sea into Holland. The richest deposits are situated along a strip of coast between Memel and Dantzic, but the real home of amber has been supposed to lie in the bed of the Baltic between Bornholm and the mainland. It rests upon Cretaceous rocks, and consists chiefly of their debris, forming a peculiar mixture known as "blaue-Erde," which appears to exist throughout the Province of Samland at a depth of 80 to 100 feet, and to contain an almost inexhaustible supply of amber. The authors wish to correct the name to "blau-grün," to distinguish it from the blue earth which accompanies the brown coal in Silesia and elsewhere. Immense quantities of amber are washed out to sea from the coast, or brought down by rivulets and cast up again during storms or in certain winds. The expectations that amber-bearing beds of equal richness would be found at greater depths farther from the sea have not been realised, and these already priceless and apparently inexhaustible coast-deposits have thereby acquired an enhanced importance. It seems probable that the amber-beds of the North Sea belong to the same formation, and that these may even have been continuous to the east coast of Great Britain.

Though the greatest quantity of amber is found on the coast, the largest pieces, 6·5 and 9·5 kilos., were met with inland. It is never found in paying quantities at a greater depth than 4 to 6 feet, and chiefly in the "diluvial beds" with rolled fragments of brown coal, wood, and stones. It is rare in the brown-coal formation, and even when met with is almost confined to the Upper blue and plastic clays. The quantity, however, seems to be inexhaustible, for the rich and celebrated blue-earth of Samland extends along the coast for 60 miles, and possesses a breadth of about 12 miles and an average thickness of 10 feet. Runge estimates that each cubic foot contains $\frac{1}{12}$ lb. of amber, which gives a total of some 9,600,000,000 lbs. The actual yield at present is 200,000 to 300,000 lbs. per annum, or at least five times the quantity estimated to be cast up by the waves of the Baltic on this coast, so that it appears, at the present rate of quarrying, there is a supply for some 30,000 years to come. A good deal of amber, it must be remembered, is cast up on other Baltic shores and along the North Sea.

In an inquiry as to the probable extent of Pine forests that would be required to produce such a bulk of amber, the authors take the Norway Spruce (*Pinus abies*, Linn.) for the purpose of comparison. Estimating that the full age of the species is 120 years, sixty to seventy of which are resin-producing, they conclude that 6000 lbs. per acre would be the product of each generation, and therefore that the Baltic Sea, with its area of 6370 German miles, might yield, if covered with Norway Spruce, 8,408,400,000 lbs., or about an equivalent to the quantity contained in the 20 German square miles of the Samland "blue-earth" referred to above. It thus appears that if this amber in it had been produced on the spot, some 300 generations would have been required to furnish it, but it is of course far more probable that it has been collected together in its present position by the action of water. These estimates being founded on a species relatively poor in resin, even notoriously less resinous than *Pinus austriaca* and other existing species, it is likely that the amber yield was in excess.

The Amber Flora presents a group of cryptogams comprising 20 Fungi, 12 lichens, and about as many mosses—plants hardly represented in any other Tertiary Flora. It is united to other Miocene Floras, not only by its Coniferæ, but by the widely-spread *Cinnamonum polymorphum*. It contains 42 species of Conifers, Cupuliferæ, Betuleæ, Salicineæ, &c., a species of Hakea, in all 27 Monopetalæ and 12 Polypetalæ, including such rarely preserved orders as Scrophulariaceæ, Primulaceæ, Caprifoliaceæ, and Loranthaceæ, the gatherings from forest, meadow, and fen. These are to be described in a forthcoming work. The Coniferæ are, however, of chiefest interest, more especially as, while resembling the resinous species of the present day, their secretions differed so essentially in quality as to have left a product unknown in any other geological age.

J. STARKIE GARDNER

THE STORY OF A BOULDER

THE Warwickshire papers report a curious open-air service held on Sunday last at Stockton, near Rugby, to "consecrate" a large granite boulder which has been inscribed and railed in at the expense of the villagers. It lies on a bed of concrete in the centre of the little place, protected by a handsome iron railing; a few square inches are polished to show the grain; an inscription records that it was brought from Mount Sorrel, a distance

of sixty miles, by an iceberg or a glacier in the great Ice Age; and the ground around it is to be inclosed, turfed, planted, and set with rustic seats. A fine day, and the novel proceeding, drew a large and attentive crowd; a short, bright service was conducted with the aid of an unusually good village choir; and the big stone set up by Joshua at Shechem formed the text for a sermon intended to stamp the boulder as a religious no less than a scientific monument.

This charming little idyll is the closing chapter in a story which might claim to share the title made historic by a great geologist. Five years ago the present rector, coming to Stockton, found the boulder lying in a ditch, into which it had been rolled from its inconvenient position by the roadside. A hazy clerical belief that it was "Druidic" had saved it from complete destruction; but it was the cockshy of all the children, bonfires were lighted on it occasionally, and it lay at the mercy of every field club which might come hammering that way. Large, glaciated, and of granite, it was clearly worth preserving. The new rector told its probable history from the pulpit, and the village mind was roused. Reports came in of other big stones far and near, some of which were also of glacial origin; the quarrymen in the adjoining lime-works, digging down to a smaller piece of granite and some beautifully striated blocks of sandstone, protected instead of breaking them; and by following up the hint thus given, a fine bed of boulder clay was uncovered, shown to Dr. Crosskey, and inserted in the Boulder Committee Report of the British Association. The fame of the great stone spread; visitors came to see it; the Stocktonians, who had through frequent lectures learnt its scientific value, became proud of their "Pibble" and of their ability to instruct their neighbours; the subscription point was reached, and money found to move and rail in the treasure; the surrounding villages finally emptied themselves to attend the consecration service, and Stockton is at this moment, like douce Davie Deans, "as uplifted as a midden-cock on pattens."

The moral of the story is twofold. First: what has been done in Stockton ought to be done in scores of other villages. This boulder was the first link in a chain of evidence, lengthening ever since, in favour of a new and pregnant probability, the current of an ice-sheet from the Charnwood Forest heights across the table-land of South Warwickshire. In countless corners more lie similar monuments, unknown and doomed, which, if thus preserved and studied, would afford the keys to like problems in geology. And secondly: the clergy ought to do it. Our country parsons are, if they could be educated to see it, the natural discoverers and conservators of local relics; with the opportunities they have and the attainments they ought to possess, they might in their mere leisure write such a scientific history of England as no country has yet possessed. Let them read the delightful chapter in *Le Maudit*, which paints the Curé Julio in his Pyrenean parish, and in order that they may be qualified to imitate him, let the bishops be wise in their generation, and exact a knowledge of some branch of natural history from every candidate for Orders.

REPORT OF THE PARIS OBSERVATORY FOR THE YEAR 1882

WE have received from Admiral Mouchez, the Director of the Paris Observatory, the report on the state of that Observatory for the past year, and as we recently made reference to the state of our own Greenwich Observatory on the occasion of the visitation which took place at the beginning of the present month, we think it may interest our readers if we make a few extracts from this report of Admiral Mouchez.

The report opens with a complaint that the service of the Observatory has been very considerably deranged by the preparations for the transit of Venus. Not only did the various members of the expedition attend at the Observatory in order to be trained either in photography or in the use of the artificial transit, but no less than five of the *personnel* of the Observatory themselves took part in the work. At the same time, says Admiral Mouchez, the past year may take rank with any of its predecessors when the increased work of the Observatory is taken into account, for during this time an extension of ground has taken place, the equatorial coudé has been installed, and several underground chambers have been constructed for the purpose of studying magnetism and terrestrial physics generally. Curiously enough, one of the grounds on which the addition of magnetical studies to the work of the Observatory is urged is, that the cloudy skies of Paris so frequently interrupt the purely astronomical observations, that, without some such work as it is now proposed to add, the observers would frequently have little to do.

Among the purely astronomical work of the Observatory which has been going on for the last four years is that of the revision of Lalande's catalogue of stars, numbering 40,000. Concerning this work, we are informed that the General Catalogue, which will form eight volumes in quarto, is well in hand, and it is hoped that two volumes will be published each year, or at all events four volumes during the next three years. To assist in the construction of the catalogue, 110,000 meridian observations have been made during the last four years.

The employment of ordinary equatorials in an observatory, remarks Admiral Mouchez, necessitates a continual change of position of the observer, he being compelled to follow the movement of the eyepiece into positions which are often inconvenient and fatiguing, whilst the heavy dome of the observatory has also to be constantly rotated to follow the motion of the telescope. In order to obviate the necessity for this, M. Lœwy conceived the idea of adapting to the equatorial the system of "lunette brisée," employed first in England, and afterwards to a greater extent in Germany, especially in small transit instruments.

The new coudé equatorial may be thus described:—The polar axis of the instrument is supported at its extremities on two pillars like a meridian instrument. Round this axis the telescope turns, forming a right angle at the lower support. By means of a mirror placed at the summit of this angle the light is reflected along the pierced axis, at the end of which the eyepiece or the micrometer is placed. Under these conditions, with the telescope at rest, the equatorial stars pass across the observer's field of view. But of course the telescope must not be limited to the observation of equatorial stars. In order to secure the observation of other stars, a mirror free to rotate is placed before the object-glass and connected with the declination circle. The inclination of this mirror may be changed so as to throw the light coming from a star of any declination into the tube. This arrangement therefore permits the observer to explore every part of the heavens without quitting his position at one end of the polar axis. The telescope may, practically, by a rotation of this axis, be directed towards any part of the celestial equator, whilst a star of any declination may be made to throw its light down the broken telescope by means of the external mirror. It might be imagined that in this latter case the double reflection would result in the loss of a good deal of light, but we read that the preliminary experiments have shown that this is not the case, and that the polish and figure of the mirrors are very satisfactory. They are silvered, and of course can be easily repolished. We should add that this instrument, now one of the actualities of the Observatory, is due to the liberality of Mr. Bischoffsheim.

With regard to more strictly physical observations, those who have made their complaint respecting the

recent weather in England will perhaps find a grain of consolation in the statement that M. Thollon, who comes every summer to work in connection with this part of the Observatory, spent his whole summer there last year without being able to make a single observation. M. Egoroff, Professor of Physics at Warsaw, was, we learn, occupied during the months of July and August, as in preceding years, with the spectroscopic study of atmospheric absorption, working with a beam of electric light sent from Mont-Valérien to the Observatory.

Most of our readers are aware that the French Government has, as we think wisely, determined to separate the special meteorological investigations from the astronomical work of the Observatory. In consequence of this decision, Admiral Mouchez is now making meteorological observations of possibly a still higher value, with the special object of determining the different corrections, such as for refraction, to be applied to the astronomical observations.

The magnetical observatory which is now being completed will evidently be one of the first order. Six subterranean chambers of constant temperature have been built under the best possible conditions of isolation and stability. An outer wall of nearly 2 m. thickness incloses a rectangular space 40 m. in length, and 14 m. wide, completely impervious to moisture. The observing chambers, of which there are four of 5 m. by 4 m., and two of 6 m. by 5 m., are constructed in this space, being isolated from its walls by passages 2 m. wide. The walls of the observing chambers themselves are 80 centimetres thick; they communicate with each other by doors 1½ m. wide, and have a height of 3·65 m. The vaulted roof, 1 m. thick, is covered by earth to the thickness of 2 m., whilst grass and plants protect the soil from the direct rays of the sun, and from frost. The observing chambers can either be lighted by gas or by reflection from without.

Advantage has been taken of the existence of these chambers by placing in them the clocks from which the time is distributed throughout Paris, but in spite of all precautions it is unfortunately discovered that the chambers are not altogether free from minor trepidations resulting from the traffic of the streets. It is proposed therefore to place the apparatus for the study of the vertical and slow movements of the soil to a gallery in the Catacombs 27 m. below the surface. This apparatus has been constructed and is ready for use.

Among the meteorological work to be done with the object to which we have previously referred is included a series of observations from a captive balloon. This is of such a size that with ordinary gas in calm weather it can take self-registering barometers, thermometers, and hygrometers up to a height of 500 m., and with pure hydrogen it can ascend to a height of 800 m. It has been found by experiment that the balloon cannot be well managed if the air has a velocity greater than 4 m. or 5 m. per second; but this is not regarded as being inconvenient, because it is during complete calm that those great and frequent inversions of the law of decrease of temperature which most sensibly interfere with astronomical refraction, manifest themselves.

Simultaneous observations will be made on the meridian of the Observatory of Paris, north at the Observatory of Montmartre, and south at the Observatory of Montsouris.

The construction of the great refractor of 16 m. focal length with its dome of 20 m. in diameter is going on steadily. The object-glass worked by M. Martin is already finished, and the ground on which the Observatory is to be built is now prepared. There are some interesting details in the report touching the dome, the dimensions of which we learn will be the same as that of the Panthéon, and the largest ever attempted.

In insisting upon such a dome turning with ease, it must not be forgotten that it would be useless to construct one of such dimensions, unless steps were taken to prevent the ill effects which would arise from any displacement or deformation of the soil on which the Observatory is to be erected, or the walls of the Observatory itself. The arrangement which is to be adopted in the construction of this dome is that proposed by M. Eiffel. In order to reduce to a minimum. the resistance due to friction on circular rollers, M. Eiffel proposes to float the dome by means of a circular caisson plunged in a receptacle of the same form, filled with a liquid which will not freeze, such as an aqueous solution of chloride of magnesium. An experiment made with a small model gave hopes of the most satisfactory results with this arrangement. There is much originality in the idea, and at the Paris Observatory more than anywhere else perhaps it is necessary that some such arrangement as this should be adopted, for it must not be forgotten that the Observatory is situated over the Catacombs, one result of which has been that for many years the pillars of the meridian circle erected in the gardens have gradually inclined towards the east in consequence of the displacement of the soil. If the same thing were to happen to the Observatory for the great equatorial, there is little doubt that before many years were over the dome would be quite immovable, whereas with Eiffel's floating arrangement, whatever be the change in level within season due to such a cause as we have named, the dome would still turn.

Another point which is engaging the attention of the Director is the erection of an astronomical observatory on the Pic du Midi, at a height of 2859 m. At this elevation, according to General de Nansouty, it is easy to read at night by the light of the stars alone, and fifteen or sixteen Pleiades are visible to the naked eye. It is indeed time that the importance of the possibility of observations at great heights received a fuller recognition. When the astronomical party were in the Rocky Mountains in 1878, to observe the eclipse of the sun there, three American observers had no difficulty in detecting the satellites of Jupiter every night with the naked eye. Nothing could show better the purity and transparency of the air than this, and to establish these facts is to establish also the necessity for utilising them. It is intended that any astronomer who wishes to make any special researches may take advantage of this Pic du Midi Observatory. At the same time, however, astronomers will be sent from the Paris Observatory to profit by the clear skies of the south at those times when the climate of Paris reduces the number of possible observations in the Observatory itself. It is pointed out that not only the science of astronomy, but physics, chemistry, and physiology, will probably derive great benefit from the institution of such an observatory as this.

NOTES

THE Royal Society Soirée last Wednesday was as successful as usual, though the absence of the president, Mr. Spottiswoode, through illness, was to be regretted. From inquiries last night we are glad to learn that Mr. Spottiswoode, who is suffering from Roman fever, is going on very well.

THE candidates selected by the Council of the Royal Society, whose names we gave in NATURE, vol. xxvii. p. 614, were elected last Thursday.

DR. MICHAEL FOSTER has, in accordance with unanimous expectation, been elected to the newly established Professorship of Physiology in the University of Cambridge; and Dr. Alexander Macalister, F.R.S., Professor of Comparative Anatomy and Zoology in the University of Dublin, has been elected to the Professorship of Anatomy, vacant by the resignation of Prof. Humphry.

IT will gratify our readers to learn that Her Majesty has subscribed 50*l*. and the Prince of Wales 26*l*. 5*s*. to the fund now being raised by the Scottish Meteorological Society for the establishment of a Meteorological Observatory on the top of Ben Nevis. At a meeting of the Council of the Society on Saturday last, we understand that plans and specifications and offers from several contractors for making a road from Fort William to the top of Ben Nevis were submitted, and it was resolved to commence the making of the road at once; Mr. Sydney Mitchell, architect, was instructed to make arrangements for the completion of the work within two months.

PROF. MORRIS has presented to University College, London, his valuable geological library.

THE following subjects have been settled for conferences at the Fisheries Exhibition; the authors whose names are given have consented to read papers. Many gentlemen have consented to act in this capacity, but the complete list is not yet ready:—British Fisheries and Fishermen, by H.R.H. the Duke of Edinburgh; the Fisheries of the United States, by Prof. Brown Goode; the Fisheries of the Dominion; the Fisheries of other Countries (Commissioners for Sweden, Norway, Netherlands, China, &c., have promised to take part in these conferences); Herring Fisheries, by Mr. R. W. Duff, M.P.; Pilchard and Mackerel Fisheries, by Mr. J. Cornish; Salmon and Salmon Fisheries; Fresh Water Fisheries (including Trout), by Mr. Francis Francis; Seal Fisheries, by Capt. Temple; Oyster Culture and Fisheries, by Prof. Hubrecht; Mollusks, Mussels, Whelks, &c., used for Food or Bait, by Mr. Chas. Harding; Line Fishing, by Mr. C. M. Murdahl; Trawling; the Application of Steam Power to the Fishing Industry; Principles of Fishery Legislation, by the Right Hon. G. Shaw Lefevre, M.P.; Fish Culture and Acclimatisation of Fishes, by Sir James Maitland; Fish as Food, by Sir Henry Thompson; Fish Transport and Fish Markets, by His Excellency Spencer Walpole; Food of Fishes, by Dr. F. Day; Storm Warnings, by Mr. R. H. Scott; Fish Diseases, by Prof. Huxley; Economic Condition of Fishermen, by Prof. Leone Levi; Protection of Life of Fishermen; Scientific Results of the Exhibition, by Prof. Ray Lankester.

THE Committee appointed by the French Parliament to consider the pension to M. Pasteur, have agreed to recommend its increase from 12,000 francs to 25,000, with reversion to the widow and children.

PROF. LENZ is about to organise, with the aid of the Russian Geographical Society, a series of observations on terrestrial currents along four lines of Russian telegraphs—Moscow to Kazan and to Kharkoff, and Tiflis to Rostoff and Baku. The necessary instruments are ordered, and the observations will begin as soon as these are ready. These observations were highly recommended, as is known, by the International Polar Committee at its Hamburg meeting, in connection with the magnetic observations of the circumpolar stations, as well as by the Electrical Congress at Paris. Germany has already begun these observations, whilst Austria, Sweden, and Finland are about to start them.

As the Russian Meteorological stations on Novaya Zemlya and at the mouth of the Lena were unable to begin regular magnetic observations on September 1, 1882, and their observations during the first months probably will not have the desired degree of accuracy, the Meteorological Committee of the Russian Geographical Society has applied for grants of money to continue these observations for one year more. Two new meteorological stations have been opened at Obdorsk and at Mezen, in order to connect the Novaya Zemlya observations with those of Central Russia.

ON the 5th inst. the Emperor of Austria inaugurated the new Vienna Observatory, on the Turken Schanze, in the northern outskirts of the town. The new building took nine years to construct, and during that time the present director went all over Europe and America in order to study the fitting-up of the best observatories. The result is that the Vienna Observatory is probably one of the most complete in existence. For an account of the great telescope, constructed by Grubb of Dublin, see NATURE, vol. xxiv. p. 11.

A COMPETITION has been opened by the Genevan Society of Physics and Natural History for the best unpublished monograph on a genus or family of plants. The MSS. may be in Latin, French, German (in Roman writing), English, or Italian, and should be sent to Prof. Alph. de Candolle, Cour St. Pierre, 3, Geneva, before October 1, 1884. Members of the Society are not admitted to the competition. The prize is 500 francs.

M. MARCEL DEPREZ, the author of the experiments on the transmission of force to a distance, has offered himself as a candidate for the place in the Academy of Sciences vacated by the death of M. Bresse, in the section of Mechanics.

THERE was an interesting gathering at Newnham, Cambridge, on Saturday, to celebrate the success of the College for Women, started there some years ago, and to honour its first and as yet only Principal, Miss Clough, by presenting her portrait to the institution. The progress which has been made in the higher education of women since Newnham was founded is striking. Though only a few years ago the attempt was barely tolerated by the University authorities, now the students are all but nominally attached to the University, and there can be no doubt that ere very long they will obtain all that the friends of these institutions desire. Miss Clough deserved all the honour paid her on Saturday, for mainly to her courage, intelligence, and tact has the wonderful success of Newnham been due.

Apropos of the education of women and of the callings for which they are suited, it is a remarkable fact that the recently opened Brooklyn Bridge, of which we have heard so much as one of the greatest triumphs of engineering, owes its existence partly to the genius of a woman. Mrs. Washington Roebling, the wife of the great engineer who was intrusted with the construction of the Brooklyn Bridge, has been chief of the engineering staff ever since her husband first fell ill. When he was disabled and could not proceed with his great work, Mrs. Roebling began to study engineering, and her success was such that in a short time she was able to take her husband's place, and the enormous structure which Americans not incorrectly call "one of the most conspicuous marvels of the nineteenth century" was completed under her direction. The honour of being the first to drive across the new bridge was well earned by Mrs. Roebling, and the peculiar share which she had taken in its construction was rightly held to justify a disregard of the old superstition which dooms to ill luck the structure over which a woman has been the first to cross.

PROF. A. H. KEANE has been elected a Corresponding Member of the Anthropological Society of Washington.

THE fifth International Congress of Americanists will be held at Copenhagen, August 21–24. King Christian will be "Protector" of the Congress, while Prince Frederick Christian will be Honorary President. Prof. Worsaae is President of the Committee of Organisation. The subjects to be discussed cover a wide field, including history and geology, archæology, anthropology and ethnography, linguistics and palæography.

THE Duke of Westminster has intimated to the Council of the National Smoke Abatement Institution that he purposes to contribute 500*l*. to the Smoke Abatement Fund recently opened.

WE learn from the Spanish papers that the Mining Exhibition now open at Madrid, is a great success. However incomplete, it still represents to a certain degree the present state of this wide branch of national welfare of Spain, and probably will give an impulse to the further development of geology, which is one of the most popular sciences with the Spanish *savants*.

THIRTY-TWO schemes were examined by the jury for the erection of a statue to Christopher Columbus at Barcelona. The most accredited opinion in Spanish artistic circles is, however, that none of them corresponds to the greatness of the event of the discovery of a new continent, which it has to commemorate. The statue will be erected on the seashore, facing the port of Barcelona.

A WRITER in the *Times* on the present Czar of Russia and his two predecessors refers to some improvements which have been made during the present reign. "The most hopeful of all recent signs in Russia," he says, "has been the entire cessation of the ecclesiastical censorship that was formerly exercised over scientific writings. The censors used to be attached to the Universities; many of them were nominees of the higher clergy; and books that were considered unorthodox were never licensed by them unless the author paid fees which deprived him of all profit in his work. This, at least, was generally the case, and if an author evaded payment it could only be through the patronage of some very powerful man. M. Delyanoff has allayed much irritation among Russian *savants* and given a valuable stimulus to University education by limiting the jurisdiction of the censors to political works. So we shall hear no more of books being suppressed—as one was by Count Tolstoi—for inquiring too minutely into miracles alleged to have been wrought by bones of saints drawn from the catacombs of Kieff and sold by the clergy at high prices."

I have received the sixteenth volume of the *Memoirs of the Society of Naturalists at the Kharkoff University*. It is mostly occupied by a long paper by A. W. Guroff, on the geology of the provinces of Kharkoff and Ekaterinoslav, being a valuable addition to the former work by Prof. Levakovsky, "On the Cretaceous and subsequent Formations," and to the works of MM. Borisyak, Briot, Klemm, and many others. The author describes at length the crystalline rocks of the rapids of the Dnieper, and gives a map of their extension, as well as a classification of this complicated series. He then mentions the littoral formations of the coal-basin of the Don, as well as the coal-measures of the Kalmius, and dwells at some length on the Bakhmut depression, describing the different stages of its Permian deposits. As to the much-discussed question of the upper members of this formation, which are considered by several Russian geologists to belong to the Trias, he is inclined too to consider them as intermediary between the Permian and the Jura, as they contain remains of the *Posidonomya* (*Estheria*) *minuta* and the *Equisetum arenaceum*, which both characterise the same formation on the Volga. The Jurassic deposits which unite the Jura of the Don with that of Kieff, as also the Rhetic group of the Donets, are then dealt with, and a complete list of the Donets Jurassic fauna is given. The Donets Jura proves to be more like the Jura of middle Europe than that of middle Russia. The Tertiary deposits of Kharkoff (the *Spondylus* beds) seem to belong to the Eocene formation, which is covered with sand and sandstone of the Miocene period. The other papers of the same volume are a supplementary list of 200 Diptera of Kharkoff, by W. A. Yaroshevsky, bringing their number up to 908 species; and a note on the parasites of the *Stauronotus vastator*.

THE researches as to the invertebrate fauna of the Black Sea, which were made from 1833 to 1863 by Rathke, Nordmann, Kessler, and Wagner, which researches had brought only to forty the number of species of crustaceans discovered in the Black Sea, have contributed towards spreading the idea as to the remarkable poverty of this fauna. This opinion was rapidly overthrown by the more recent researches of MM. Czerniawsky, Markusen, and Bobretsky, who discovered in the space of a few years no less than 130 new species of crustaceans in the Black Sea, and brought, in 1869, the total number of crustacean species discovered there up to 160. The subsequent dredgings of MM. Krichaguin, Grebnitsky, and Czerniawsky added to the number seventy-six species more, and this last explorer even affirmed in one of his memoirs that the crustacean fauna of a single bay of the Black Sea—the Bay of Yalta—is richer than that of the whole of the Belgian coast. The opinions, however, as to the kinship of the Black Sea fauna with the faunas of the neighbouring seas are still divided. MM. Markusen and Grebnitsky maintained that it is closely akin to that of the seas of the north, and proved it by the presence of such crustaceans as are not met with in the Mediterranean (various species of *Mysis* and representatives of the groups of the *Cumacea*, *Bathyporeia*, *Niphargus*, *Padocerus*, and *Siphonacetes*), but are common in the seas of the north. They pointed out also the circumstance that the forms which are the most numerous in the Black Sea are either cosmopolite forms or such as are common in the northern seas, but not those which might have immigrated from the Mediterranean. In a notice published in the last volume of the *Memoirs of the Kieff Society of Naturalists*, M. Sovinsky points out, however, that the reverse opinion—which admits a close relationship of the Black Sea crustaceans with the Mediterranean ones—gains more and more ground during these last few years. The Mediterranean fauna was of course submitted to the influence of the northern faunas, and its northern forms might have found an appropriate medium in the less salt water of the Black Sea; but the Black Sea fauna looks rather as a part of the fauna of the Mediterranean basin, slowly modified by the medium it inhabits; this opinion is supported, in fact, by the kinship of several Black Sea forms with those of the Mediterranean and the Red Sea, and by the richness of the Black Sea fauna in mere varieties and in such forms as are purely local, the prevailing types of the fauna being still the cosmopolite ones. The Black Sea fauna would be thus but a part of the Mediterranean fauna, but much impoverished and modified to a great extent by the variety of local conditions.

RUSSIAN geologists do not seem to hesitate in admitting the aqueous origin of granitic rocks which formerly were unanimously considered as igneous and eruptive. The late Prof. Barbot de Marny adopted this theory during the last years of his life, and the same theory is supported now with regard to the Dneiper pegmatites, by M. Gouroff, in the *Memoirs of the Society of Naturalists* at the Kharkoff University (vol. xvi.). After a thorough study of the granitic rocks of the rapids of the Dnieper, he describes these rocks, consisting of orthoclase, plagioclase, quartz, and biotite (this last and the orthoclase being often substituted by chlorite and epidote) as granitites. These granitites always appear stratified, and alternate with granitic gneisses, their stratification being well developed with an inclination towards N. 70° E. at 60°. They are also crossed with numerous veins of pegmatite. The quartz of the pegmatite contains large microscopical inclusions of water, sometimes with carbonic acid, and with solutions of natrium and calcium chloride; it is coloured brown, which colour disappears when it is heated. The veins of pegmatite contain large crystals of quartz and orthoclase. They decrease towards their lower ends and terminate in accumulations of crystalline quartz. They very often interfere with veins of quartz, either crystalline (with microscopic inclusions of water), or opal-like. M. Gouroff proposes to discuss further the question as to the origin of the peg-

matite veins in another paper, but he meanwhile points out that these veins are subsequent to the formation of the granitite and gneiss, and that, like the quartz veins, they are of aqueous origin.

In connection with the celebration of the centenary of ballooning, some foolhardy aëronauts have been attempting to cross the Channel through the fickle air. One, named L'Hoste, who started on Friday night from Boulogne, was missing till yesterday, when news reached Paris from Antwerp that he had been rescued in the North Sea by a French lugger bound for that town.

The Swedish Academy of Agriculture has proposed to the Government that a sum of 50*l.* be granted to Dr. R. Lundberg for a visit to the International Fisheries Exhibition. The proposal will most likely be granted.

On May 28, between 6 and 7.30 p.m., a magnificent mirage was seen at Finsbo, in Norra Ryrs parish, Sweden. During nearly two hours, with intervals of three to four minutes, a panoramic landscape was seen, with mountains, lakes, forests, and farms. To the eye the view appeared as if only three-quarters to one (English) mile distant.

Last year several Swedish merchants contributed a sum of 100*l.* to enable the Swedish Doctor of Zoology, C. Bovallius, who has been travelling in Central America, to forward rare zoological specimens to the Upsala University. Herr Bovallius has from time to time sent some valuable collections of insects and birds to this institution.

The additions to the Zoological Society's Gardens during the past week include an Ourang-outang (*Simia satyrus* ♀) from Sumatra, presented by Mr. J. M. Vermont; two Duyker Boks (*Cephalophus mergens* ♂ ♀) from South Africa, presented by Mr. H. H. Trevor; a Philippine Paradoxure (*Paradoxurus prehensilis*) from the Philippine Islands, presented by Mr. A. Burgess; a King Parrakeet (*Aprosmictus scapulatus*) from Australia, presented by Mrs. Lewin; a Lesser Sulphur-crested Cockatoo (*Cacatua sulphurea*) from Moluccas, presented by J. Snowdon Henry, F.Z.S.; two Viperine Snakes (*Tropidonotus viperinus*), a Dark Green Snake (*Zamenis atrovirens*) from North Africa, presented by Mr. J. C. J. Church; two Aye-ayes (*Chiromys madagascariensis*) from Madagascar, a Carpet Snake (*Morelia variegata*) from Australia, received on approval; a Hybrid Luhdorf's Deer (between *Cervus leuhdorfi* ♂ and *C. canadensis* ♀), ten Australian Wild Ducks (*Anas superciliosa*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

Cometary Refraction.—M. W. Meyer, of the Observatory of Geneva, has published a discussion of three series of micrometrical observations, made during as many near approaches of the great comet of 1881 (1881 III.) to stars, when the latter were seen through the denser parts of the head of the comet, the immediate object of the micrometrical measures of distance between the nucleus and the star being the detection of any deflection or refraction of the light of the star in passing through the cometic nebulosity. This comet offered a great advantage in an investigation of the kind, inasmuch as its nucleus had perfectly the appearance of a fixed star. M. Gustave Cellérier had treated the question from a theoretical point of view in a memoir published in *Archives des Sciences Physiques et Naturelles*, of Geneva, of October 15, 1882; the conclusions are reproduced in abstract by M. Meyer, who has applied the resulting formulæ to the case in question. The first series of observations was made on June 29, 1881, when the comet passed close to the star 519 of *Durchmusterung* + 65°, which is No. 6594 in Oeltzen's Catalogue, of 7·8 mag. The second series, on July 13, when the comet approached the star ι Draconis (Hev.) within about 38″, and the third series on August 1, when it passed about 24″ from a star of 9·10 mag. For details of the method of treating the observations we must refer to M. Meyer's paper, which appears in *Mémoires de la Société de Physique et d'Histoire Naturelle de Genève*, t. xxviii.; he sums up his conclusions as follows:—"La substance dont la chevelure de la grande comète de 1881 a été composée s'est optiquement comportée comme un gaz, et sa puissance réfractive à une distance de 10,200 kil. du noyau a été pendant l'époque des observations de 0·0000093. La pression de ce gaz diminuait dans les régions étudiées proportionnellement au carré de la distance au noyau." He does not venture to say, however, that this value exactly represents the refractive power of the comet, though he believes in a measurable force.

M. Meyer remarks that previous attempts to detect a deflection of light in traversing the substance of a comet had led only to negative results. Bessel availed himself of the conjunction of Halley's Comet with a star of the tenth magnitude on September 29, 1835, to discover by heliometric measures an effect of this kind, but without success. His measures have been subjected to a new reduction, in accordance with M. Cellérier's theory, by M. Meyer, though with similar negative result.

Kepler's Nova of 1604.—The position of this famous star is now favourably situated for observation. It is most readily found by reference to a star of 8·9 mag., which occurs in Argelander's southern zones, and which is No. 16872 of Oeltzen's Catalogue. The place of this star for 1883·0 is in right ascension 17h. 24m. 2·9s., declination − 21° 23′ 34″. By Prof. Schönfeld's reduction of the observations of Fabricius in 1604, Kepler's star would precede 25·3s. in R.A. 0′·8 to the north. There is a star 11·12m. preceding 17·9s. and 1′·6 south of Argelander's, and another 12m. preceding 33·2s. and 2′·7 north; it is to the latter object, which was observed by Prof. Winnecke in 1875, though not previously glimpsed with a refractor of 7 inches aperture, that attention may be chiefly directed. It is to be remarked that the position of Kepler's star is liable to greater uncertainty than that of Tycho's star in 1572. It is very desirable that whatever may be the result of examination of the vicinity, it should be put upon record (of course with the corresponding date) from time to time. The Chinese annals have references to more than one of their stellar class *Ke-sing* or "extraordinary stars," in earlier times, which must have been situate in the neighbourhood of Kepler's *Nova*.

The Binary Star, γ Coronæ Australis.—Several years since an orbit was calculated for this object by Prof. Schiaparelli, who made use of measures up to 1875, whence it appeared that the periastron passage would take place about the end of 1882. Mr. Downing, availing himself of measures to 1880, has applied small corrections to the elements found by the Milan astronomer, and fixes the periastron passage to 1883·203, the period of revolution being 54·985 years. The binary is therefore describing at present a critical portion of the orbit, and, it may be hoped, will not be neglected by those observers of double stars who can well command its position. The following are angles and distances calculated from the two orbits:—

	Downing		Schiaparelli	
	Pos.	Dist.	Pos.	Dist.
	°	″	°	″
1883·50	134·2	0·27	93·3	0·38
83·75	103·8	0·32	80·4	0·50
84·25	74·6	0·55	59·5	0·73

The Saturnian Satellite, Mimas.—M. Meyer, observing with the 10 inch refractor presented to the Observatory of Geneva by the late director, Prof. Plantamour, succeeded in obtaining, near the opposition of Saturn in 1881, several sets of measures of the faint satellite, *Mimas*, about the time of greatest elongation. Considering the small number of measures of this object which have been obtained even with the largest instruments, M. Meyer's success is worthy of attention. On two nights he secured complete series of measures, and on other occasions partial ones. We find, on adjusting the circular elements adopted in this column for prediction of the positions of *Mimas* (which were founded upon Washington observations and required but small correction) by Prof. Frisby's observation of the conjunction of the satellite with the minor axis of the ring southwards, on November 8, 1882, that M. Meyer's measures are closely represented.

GEOGRAPHICAL NOTES

AT the meeting of the Royal Geographical Society on Monday night Sir Henry Rawlinson read the following telegram, forwarded by the Eastern Telegraph Company from Zanzibar, with regard to the movements of Mr. Joseph Thomson:—"Thomson reached Dgare na Erobi, in Masai country, long. 37°, lat. 3·5, on May 5. Was compelled to flee during night to evade what could only have been a disastrous fight, through troubles raised by Fischer's caravan in front. Got safely back to Taveta, where he camped his men, and has come down to Mombasa with small party in seven marches to replenish his goods, which has become necessary in consequence of his retreat from Masai and prolonged detention at Taveta. Returns in a few days to Taveta to proceed by Arusha, probably in company of another caravan. Is in good health. Details by post."

THE Russian Geographical Society has awarded its great gold medal to H. W. Abich, Member of the Academy of Sciences, for his researches into the Geology of the Caucasus. The gold medal of Count Lütke has been awarded to W. K. Döllen, astronomer of the Pulkova Observatory, for his new improved instrument for the determination of latitudes and longitudes. Two other gold medals, for ethnographical and statistical works, have been awarded to M. Barsoff, for collections of songs of Northern Russia, and to M. Krasnoperoff for a statistical description of the Government of Perm. Small gold medals have been awarded to MM. Eklon and Roborovsk, who both accompanied M. Prshevalsky in his travels; to M. Oshanin, zoologist, for travels in Karategin, Darvaz, and Turkestan; and to M. Vitkovsky, for exploring graves of the Stone period about Irkutsk. Silver medals have been awarded to M. Lessar for levelling operations between Askabad and Seraks; to M. Schultz for the same between Orenburg and Lake Aral; to M. Brounoff, for researches on cyclones and anticyclones in Europe; to M. Gladysheff, for determinations of latitudes and longitudes in the Akhal-tekke oasis; to M. Kiseleff, for a journey to the Bi-shan; to M. Rodionoff, for surveys in Karategin; to M. Slovtsoff, for a description of the district of Kokchetan; also four other medals for smaller ethnographical and statistical works.

M. LESSAR, who made so interesting a journey from Askabad to Mash-had, continues to make a series of excursions in the same region. He went a second time to Mash-had *viâ* Khelat, and thence to Zurabad, Saraks, Merv, Charjui, and Khiva; then he made a barometric levelling from Askabad to Tejent, visited Merv a second time, and in December last journeyed in the mountain region of Khelat, Daraghez, and Attek, thus covering about 3300 miles from April to December.

THE proprietors of the *Melbourne Age* have despatched an exploring expedition to New Guinea.

WE mentioned in a preceding volume the late Barbot de Marny's theory as to the formation of the dunes (*barkhans*) in the steppe of Kyzyl-kum and the influence of the wind as a powerful agency in modifying the earth's surface in the steppes. We find now, in the *Zapiski* of the Kieff Society of Naturalists, several objections to this theory by M. Borschoff. Without denying the partial influence of the wind, he reduces it to a quite secondary agency, and decidedly opposes the wind-theory of the formation of *barkhans*. Wind may increase the *barkhans* to a certain amount, but their primary origin must be sought for elsewhere, and the *rôle* of the wind is far below what has been assumed. So hard a rock as the sandstone, permeated with iron and lime, of the Kara-kum and Kyzyl-kum steppes cannot be disintegrated by wind, unless it has been disintegrated beforehand by rains and rapid changes of temperature—both which conditions are missing in the steppes. Therefore on the Emba, the Ilik, the Irghiz, where the same sandstones occur—as devoid of vegetation as in the Kyzyl-kum, there are no such surfaces covered with *barkhans* as in the neighbourhood of Lake Aral. As a rule the dunes appear only where there are remains of former lakes, and in such cases they assume the directions of the shores of these former basins. Far from being dependent on the direction of the prevailing winds, the direction of the *barkhans* varies, even within short distances, and it follows the windings of the coast of Lake Aral. Thus, they inclose the Sary Cheganak bay, like the parallel steps of an amphitheatre, the same directions being also taken by the rocky ledges of the terraces of sandstone, even beneath the water of the bay. The close connection of these ridges with the former action of the interior sea is the more obvious, as these dunes—sometimes stratified in their interior—often contain remains of Aral mollusks, such as *Cardium rusticum*, *Dreissena polymorpha*, as also *Adacna vitrea*. Whole banks, from a quarter to half a foot thick, of these shells are found in the *barkhans*, and they are met with at distances of 27 miles from Lake Aral, and 70 feet above its level (at Sopak), or even 80 miles north of it, and 100 to 120 feet above its level (at the Toulagai hill), whilst the depressions between the *barkhans* contain deposits of salt, with the same shells, or with an alga similar to the Aralian *Zostera*. The primary origin of the *barkhans*, M. Borschoff says, can be discovered even now in the low coast ridges. These ridges once formed slowly increase afterwards by the accumulation of vegetation on their summits, and vegetation plays a most important part in their growth. Several Solaneæ, such as *Caroxylon*, or *Halostachys*, and Gramineæ, such as *Ærulops lævis*, grow on their summit, which is covered subsequently with various species of *Tamarix* and *Calligonum*. When deeply covered with vegetation, their further increase is due to the sand brought by the wind, the organic life still remaining a powerful agency of increase. But their original appearance must be sought for, it is contended, in the agency of water. M. Severtsoff's remarks on the influence of vegetation on the growth of the dunes, and those of the Turkestan railway expedition on the immobility of the dunes (already analysed in NATURE), go far to sustain M. Borschoff's conclusions.

AN expedition, under the direction of Col. Prshevalsky, is being organised for the purpose of scientific researches in Central Asia and Thibet. The expedition is expected to start in August next.

A SERIES of valuable papers on the island of Yezo now appearing in the *Japan Gazette* deserve the attention of geographers. They are from the pen of Capt. Blakiston, who received the gold medal of the Royal Geographical Society in 1861 for exploration on the Yang-tsze, and who has for many years resided at Hakodate, the principal port of Yezo. The papers, which have reached their fifteenth part, are so varied and complete that they may fairly be called an encyclopædia of the island. The geography, geology, fauna and flora, the progress made during the past twenty years by the Japanese administrators, the Ainos, the mineral productions are all treated, and in addition the records of numerous journeys over all parts of the island are given. It is to be hoped that these valuable papers will be published in a collected form, for no future account of Yezo will be complete in which copious reference is not made to them. The numerous reports of the *employés* of the Japanese Government to the Colonisation Department in Tokio, which are now so difficult to obtain, are largely quoted in notes

ACCORDING to a new survey of the rapids of the Dnieper, the total fall of the river, on a stretch of forty-six miles, from Ekaterinoslav to the Khortitsa Island at Alexandrovsk, is 106·5 feet. The aggregate fall of the nine rapids is 60·3 feet, and their aggregate length is 5335 yards, the greatest rapid being that of Nenasytetsky (the Insatiable) which has a fall of 19·5 feet and a length of 1867 yards. The discharge of water at the head of the rapids has been found, at a level 2·5 feet below the average, to be 27,934 cubic feet per second.

THE CAUSE OF EVIDENT MAGNETISM IN IRON, STEEL, AND OTHER MAGNETIC METALS[1]

THE extreme sensitiveness of the induction balance to all molecular changes in the structure of metals was remarked in my first paper on this subject to the Royal Society;[2] and in the case of iron and steel it is most remarkable, as the addition or subtraction of 1/500,000th part, or the addition of the smallest iron filing to an already large balanced mass of iron, is at once rendered evident and measurable.

Possessing such an invaluable instrument of research, I was desirous of investigating the molecular construction of iron and steel, but at once I met with a difficulty, viz. that magnetism itself completely changed the character of any piece of iron under investigation; consequently, finding no help or explanation of the effects produced from any accepted theories of magnetism, I was forced to investigate, by means of the induction balance, the

[1] Paper read before the Society of Telegraph Engineers and of Electricians, on May 24, 1883, by Prof. D. E. Hughes, F.R.S., Vice-President.

[2] "On an Induction Current Balance, and Experimental Researches made therewith."—*Proceedings Royal Society*, March 29, 1879, p. 56.

whole question of magnetism as existing in the interior of a magnet, and to determine the particular structure for each case, such as neutrality and polarity.

In a recent paper to the Royal Society, upon the theory of magnetism (*Proceedings Royal Society*, May 10, 1883), I described the use of and demonstrations obtained by the induction balance. In this paper I propose to confine myself to demonstrations that can be repeated without it, and whose effects can be observed by the aid of ordinary magnetic direction needles.

That magnetism is of a molecular nature has long been accepted, for it is evident that, no matter how much we divide a magnet, we still have its two poles in each separate portion, consequently we can easily imagine this division carried so far, that we should at last arrive at the molecule itself possessing its two distinctive poles, consequently all theories of magnetism attempt some explanation of the cause of this molecular polarity, and the reason for apparent neutrality in a mass of iron.

Coulomb and Poisson assume that each molecule is a sphere containing two distinct magnetic fluids, which in the state of neutrality are mixed together, but when polarised are separated from each other at opposite sides; and, in order to explain why these fluids are kept apart as in a permanent magnet, they had to assume, again, that each molecule contained a peculiar coercive force, whose functions were to prevent any change or mixing of these fluids when separated.

There is not one experimental evidence to prove the truth of this assumption; and as regards coercive force, we have direct experimental proof opposing this view, as we know that molecular rigidity or hardness, as in tempered steel, and molecular freedom of softness, as in soft iron, fulfil all the conditions of this assumed coercive force.

Ampère's theory, based upon the analogy of electric currents, supposes elementary currents flowing around each molecule, and that in the neutral state these molecules are arranged haphazard in all directions, but that magnetisation consists in arranging them symmetrically.

The objections to Ampère's theory are numerous. 1. We have no knowledge or experimental proof of any elementary electric currents continually flowing without any expenditure of energy. 2. If we admit the assumption of electric currents around each molecule, the molecule itself would then be electro-magnetic, and the question still remains, What is polarity? Have the supposed electric currents separated the two assumed magnetic fluids contained in the molecule, as in Poisson's theory? or are the electric currents themselves magnetic, independent of the iron molecule?

In order to produce the supposed heterogeneous arrangement of neutrality, Ampère's currents would have either to change their position upon the molecule and have no fixed axis of rotation, or else the molecule, with its currents and polarities, would rotate, and thus be acting in accordance with the theory of De la Rive. 3. This theory does not explain why (as in the case of soft iron) polarity should disappear whenever the exciting cause is removed, as in the case of transient magnetisation. It would thus require a coercive force in iron to cause exactly one-half of the molecules to instantly reverse their direction in order to pass from apparent external polarity to that of neutrality.

The influence of mechanical vibrations and stress upon iron in facilitating or discharging its magnetism, as proved by Matteucci, 1847, in addition to the discovery by Page, 1837, of a molecular movement taking place in iron during its magnetisation, producing audible sounds, and the discovery by Dr. Joule, 1842, of the elongation of iron when magnetised, led De la Rive, in his remarkable "Treatise on Electricity," 1853, to give his theoretical views upon magnetism in the following remarkable words:—

"The whole of the magnetic molecular phenomena that we have been studying lead us to believe that the magnetisation of a body is due to a particular arrangement of its molecules, originally endowed with magnetic virtue, but which in the natural state are so arranged that the magnetism of the body that they constitute is not apparent. Magnetism would therefore consist in disturbing this state of equilibrium, or in giving to the particles an arrangement that makes manifest the property with which they are endowed, and not in developing it in them. The coercitive force should be the resistance of the molecules to change their relative positions."

Wiedemann, in 1861, gives a theory in which he admits the fluids of Poisson, or the elementary currents of Ampère, as the cause of polarity of the molecule, but believes that the molecules are turned in a general direction in the case of polarity, and that in neutrality, like Ampère's, the magnetic axes of the molecules are turned in all directions.

Maxwell, in his remarkable treatise on "Electricity and Magnetism," 1881, page 75, gives the following *résumé* of Weber's theory:—

"Weber's theory differs from Poisson's in assuming that the molecules of the iron are always magnets, even before the application of the magnetising force, but that in ordinary iron the magnetic axes of the molecules are turned indifferently in every direction, so that the iron, as a whole, exhibits no magnetic properties." And again, page 429, Maxwell says he agrees with Weber's views, and that neutrality, or unmagnetised iron, has the axes of its molecules placed indifferently in all directions, and that the act of magnetisation consists in turning all the molecules so that their axes are either rendered all parallel to one direction, or at least deflected in that direction.

I have quoted these several theories which admit of the inherent polarity of the molecule, and in that respect they entirely agree with my own; but the induction balance at once shows that they are erroneous in the most important part, for my researches have proved that neutrality is perfectly symmetrical, that there is no case of neutrality where the axes of the molecules are turned indifferently in all directions, and that we cannot obtain perfect neutrality except when the molecules form a complete closed circuit of attraction.

I believe that a true theory of magnetism should admit of complete demonstration, that it should present no anomalies, and that all the known effects should at once be explained by it.

From numerous researches I have gradually formed a theory of magnetism entirely based upon experimental results, and these have led me to the following conclusions:—

1. That each molecule of a piece of iron, steel, or other magnetic metal is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed upon a steel bar-magnet.

2. That each molecule, or its polarity, can be rotated in either direction upon its axis by torsion, stress, or by physical forces such as magnetism and electricity.

3. That the inherent polarity or magnetism of each molecule is a constant quantity like gravity; that it can neither be augmented nor destroyed.

4. That when we have external neutrality, or no apparent magnetism, the molecules, or their polarities, arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circuit of attraction.

5. That when magnetism becomes evident, the molecules or their polarities have all rotated symmetrically in a given direction, producing a north pole if rotated in that direction as regards the piece of steel, or a south pole if rotated in the opposite direction. Also, that in evident magnetism we have still a symmetrical arrangement, but one whose circles of attraction are not completed except through an external armature joining both poles.

6. That we have permanent magnetism when the molecular rigidity, as in tempered steel, retains them in a given direction, and transient magnetism whenever the molecules rotate in comparative freedom, as in soft iron.

Experimental Evidences.—In the above theory the coercive force of Poisson is replaced by molecular rigidity and freedom; and as the effects of mechanical vibrations, torsion, and stress upon the apparent destruction and facilitation of magnetism is well known, I will, before demonstrating the more serious parts of the theory, cite a few experiments to prove that molecular rigidity fulfils all the requirements of an assumed coercive force.

The influence of vibrations, torsion, or stress of any kind upon a magnetised steel or iron rod may be seen by striking with a wooden mallet rods of hard and soft steel, also hard and soft iron previously magnetised to a known degree. The tempered steel, owing to its molecular rigidity, will lose but 5 per cent., the soft steel 60, hard iron 50, and soft Swedish iron 99 per cent. of its magnetism, the amount of loss depending not so much upon whether the metal be steel or iron, as upon its degree of hardness and softness; and as hard steel requires far more power to magnetise it to the same force than iron, it is possible to imagine a steel so hard that its molecules could not rotate, and that consequently no magnetism could be manifested from a given inducing cause, whilst a perfectly soft iron would give the maximum effect, and instantly return to its previous state. From this we might in error suppose that soft Swedish iron could not

retain its magnetism, and that its natural state would be zero, or neutrality. The apparent disappearance of magnetism, however, is here due to the extreme freedom of motion of its molecules allowing them at once to follow the comparatively feeble directing force of the earth's magnetism. We can demonstrate this by feebly magnetising a rod of soft iron held vertically, so that its north pole is at the lower portion. Upon removing the inducing magnet, or electromagnetic coil, we find that the rod retains a powerful north polarity; but if magnetised in a contrary sense, then we have only *traces* of magnetism left upon the withdrawal of the inducing cause. To succeed in this experiment, as in all others where soft iron is mentioned, we should use the best Swedish charcoal iron, thoroughly annealed at high temperature.

We find, again, that rods of steel or iron will lose far less magnetism when vibrated in the magnetic dip, or vertically, when their north poles are at the lowest extremity, than when horizontal, or still less than when their poles are contrary to those of the earth's field, and also that they will acquire their maximum magnetism from a given exciting cause when held vertically as described, and the molecules allowed greater freedom of motion to obey the directing influence by vibrations, torsion, stress, or blows upon the iron. Any influence that would tend to give greater freedom of motion, such as heat or mechanical trepidations, gives a far higher magnetic force to the iron than could be obtained without these aids.

In order to render visible the effects of motion upon magnetism, we may take two glass tubes, or ordinary phials, of any length or diameter, say, 10 centimetres in length by 2 centimetres in diameter. If we now put iron filings in these tubes, leaving about one-third vacant, so as to allow complete freedom in the filings when shaken, we find that each tube, when magnetised, retains an equal amount of residual magnetism, and that this all disappears upon slightly shaking the tube. We are thus imitating the effects of vibration. But if in one of these tubes we pour melted resin (in fact, any slightly viscous liquid, such as petroleum, suffices), we then render these filings more rigid, and then we can no longer produce by shaking the disappearance of its residual magnetism. In pouring in petroleum we have apparently been introducing a strong coercitive force, but we know that it can only have the mechanical effect of rendering the iron filings less free to turn, and so comparatively rigid. If we desire to see the effect of torsion, we have only to shake the filings so that when the tube is held horizontally the vacant space is above, and rotate it slightly (but without shaking) about a horizontal axis. Its remaining magnetism instantly disappears upon rotation, although we evidently have not changed the longitudinal position of its particles. A similar effect takes place upon a soft iron rod, for if we magnetise it and observe its remaining magnetism, we find that upon giving a slight torsion to this wire its remaining magnetism instantly disappears—a similar effect to that in the rotating tube of iron filings. But if the iron is rendered more rigid by hammering, or steel rendered hard and rigid by tempering, torsions or vibrations have but little effect, as in the case of the filings rendered rigid as above mentioned. Thus we have no longer need of an assumed mysterious coercive force to account for the retention of magnetism, for once knowing the mechanical qualities of iron and steel and their degree of molecular rigidity or hardness, we can at once predict their retentive magnetic powers.[1]

Rotation of Inherent Polarised Molecules.—Torsion, as well as mechanical vibrations, has, as we have seen, a powerful influence in aiding the molecules to overcome their inertia, and thus aid them to rotate in the direction of the inducing influence; and we may thus polarise strongly a flat, soft iron rod by simply bending or vibrating it when held vertically, and if we measure the magnetic force obtained we shall notice that the force is strictly relative to the degree of softness of the iron. Thus, with hard steel we should obtain only *traces* of polarisation, whilst with extremely pure, soft Swedish iron we obtain the maximum of force. The bar of iron or steel, being held in the earth's magnetic field, of infinite size compared with the bar, and infinitely homogeneous, cannot deflect or weaken its surrounding field. Its lower portion, being north, apparently strengthens it by its reaction, whilst its upper, south, apparently weakens the field; but, as Maxwell has shown, "the two poles of each molecule are equal and opposite, consequently the sum of each molecule and the whole mass must be zero."

[1] "On the Molecular Rigidity of Tempered Steel," by Prof. D. E. Hughes, F.R.S. (*Proceedings Institution of Mechanical Engineers*, pp 72-79, January, 1883.)

We have a far greater induced polarity in iron or steel when the iron is in thin bars or small wires, and this we should expect, as the external molecules rotate directly under the influence of the earth's magnetism, whilst those forming the interior of the bar either rotate feebly, or, as in the case of very thick bars, actually act as an armature, preventing by their influence free rotation of the exterior molecules.

Thus, as the sum of the two and equal polarities in a bar of iron is zero, it is evident that its polarity must be inherent. I have some remarkably pure soft Swedish iron wire, one millimetre in diameter, and as its inherent polar force seemed great when held vertically in the earth's magnetic field, I measured in the induction balance this force compared with a similar column of the magnetic atmosphere which it displaced. The inherent polarity of this wire, simply rendered evident by the earth's magnetism, was 15,600 times greater than the column it displaced.

We cannot, either by induction, conduction, or concentration, produce a greater force in another body of similar displacement or size, otherwise we could easily create power from a feeble source. Thus the enormously greater magnetic power observed in iron than the same column of air which it displaces must be due to the *inherent* polarity of its molecules.

Amongst numerous bars of iron upon which I have experimented, one of ordinary hoop-iron, 2 centimetres wide, 40 centimetres long, and 1½ millimetre thick, not softened, possesses sufficient molecular rigidity to be apparently uninfluenced by the earth's magnetism. When this rod is rendered neutral we have but feeble polarity—mere traces when it is held vertically under the earth's magnetic influence; but if we apply a few successive torsions or vibrations to it when thus held, we have at once several thousand times greater polarity than before. Now, if iron had the power of deflecting or concentrating the earth's magnetism upon itself, it should not require the mechanical aid to molecular rotation given to it by these torsions or vibrations. Thus we are forced to conclude at least the existence of the inherent polarity of the molecules; and, if we admit this, we must also as a necessary consequence, admit the rotation of these molecules, else we cannot explain why mechanical vibrations allowing freedom of motion should always produce the polarity in accordance with the directing cause. I have already shown that torsion and vibrations *per se* are apparently destructive of magnetism; consequently in this case Poisson's two fluids and Ampère's parallel currents should, according to their theory, be mixed or heterogeneous, whilst, according to the views I am sustaining, the polarised molecules should obey, as compass needles, any magnetic directing cause whenever sufficient molecular freedom of motion allows free rotation.

The inherent polarity of iron may again be observed by drawing a flat rod of soft iron over one or both poles of a permanent magnet. This rod will then be powerfully magnetised, its remaining magnetism, when separated from the magnet, being sufficiently powerful to strongly deflect a suspended direction needle. A few slight torsions or vibrations will then completely discharge it. Now, suppose this operation repeated successively many thousand times, if there was no inherent polarity we should have gradually drawn all the polarity out of the magnet, and discharged it into the atmosphere. Nothing of the kind takes place. The molecules of the iron are simply rotated each time, and the only energy in work expended or lost comes from the arm of the experimenter, and the energy required would be strictly in accordance with the molecular freedom, or softness and hardness of the iron and steel; thus, whilst soft iron could be easily polarised and discharged by mechanical torsions, hard tempered steel would require a far greater amount.

Dr. Warren de la Rue, F.R.S., kindly aided me in this part of the research by passing a current from his well-known chloride of silver battery through iron and steel wires. A condenser of 42·8 microfarad capacity, charged by 3·360 cells, was used. We passed this enormous electric charge longitudinally through the wires, and observations were made as to whether any change whatever was produced in their quality or inherent polarity, the result being that these wires gave exactly the same magnetic polarity from a given directing or inducing cause as before, being similar in nature and degree, consequently this enormous electric force had not changed or destroyed the original inherent polarity.

If the molecules possess inherent polarity and rotate upon their axes, similar to a series of compass needles having a slight

degree of frictional rigidity, then, upon passing one pole of a magnet above them, they would turn symmetrically in one direction, and drawing the same pole of the magnet in the contrary direction would rotate them, and they would then remain symmetrically in the opposite direction.

A precisely similar effect takes place in a soft iron rod, placed east and west a few inches above a direction needle. Upon drawing the south pole of a powerful natural magnet at a few centimetres distance above the wire from east to west, the north polarities of the molecules successively turn in the direction of west, following the attraction of the south pole, as previously seen on the small compass needles. The rod is now magnetised with its north pole west, as indicated by the direction needle below any portion of this rod. Upon passing the same south pole of the natural magnet in a contrary direction, the molecules all rotate, their north poles still turning successively to the south pole of the permanent magnet until its arrival at the end from which the first magnetisation commenced. The rod has now entirely changed its polarity, and its north pole is east.

This phenomenon is well known in the ordinary magnetisation of rods, where care is taken to draw the magnet always in a similar direction, or the poles would be reversed at each to and fro drawing. To account for this on Coulomb-Poisson's theory it would be requisite that, first, all the fluids be separated with their north fluids symmetrically in one direction, but on drawing back the magnet these fluids would have to mix together, the north fluid passing through its south fluid to be finally opposite to its previous position, its coercive force doing the double work of allowing both fluids to mix and pass through each other, and finally keep them entirely apart. Ampère's theory would require that from a haphazard arrangement the molecules should become symmetrically arranged upon the first passage of the magnet, then upon its reversed direction one-half of the electric elementary currents should successively revolve in a contrary direction to arrive at neutrality before, finally, the other half followed the direction of the first half, and now all these currents would be revolving in the opposite direction to that upon the first magnetisation. We thus see that both these theories, whilst resting altogether upon assumption, are extremely complicated and improbable.

We might suppose, from the theory which I am advocating, that upon the rotation of the molecules there would be some disturbance or mechanical trepidation; and such is found to be the case, as first observed by Page and afterwards verified by Dr. Joule and De la Rive, in the molecular sounds produced in iron upon its magnetisation. Reis's first telephone was founded upon these sounds, and Du Moncel has made numerous researches upon this subject.

In the last of my experiments cited the sounds are too feeble to be heard, but by the application of the microphone these trepidations at once become audible.

That molecules of iron and other metals rotate with time, whose period becomes shortened by mechanical vibrations, is well known in metallurgy, the ultimate result being generally the passage from a fibrous condition, as in iron wires, to a high degree of crystallisation. For many years I employed a circular vibrating spring as the regulator of speed of my printing telegraph instrument, and although this spring was so regulated by means of a frictional break, or "Frein," as not to surpass its limits of elasticity, these springs were constantly breaking after a few days' use, and as a matter of urgent necessity I made special researches into the cause of this breaking after a few days' constant vibratory action. I found at the point of rupture a high state of crystallisation. Fibrous iron would thus become thoroughly crystallised and break in one day; the number of vibrations for an instrument in constant use during 24 hours being 1,209,600. Thus we could roughly estimate the life of iron in the form of one of these springs at 1,000,000 vibrations. Copper crystallised in one hour, and all metals and alloys were inferior to steel, except aluminium bronze. The latter springs would stand six weeks' constant use, or some 50,000,000 of vibrations. I finally resolved this problem by spreading the amount of vibrating work over a spiral spring containing 3 metres of steel rod wound into the same space as previously held by the straight rod of 30 centimetres; by this means the average life of these springs has become five years. Evidently the molecules of these fibrous springs must have rotated under the vibrations, in order to produce crystals. The same phenomenon is observed in axles of carriages receiving constant trepidations, large crystals being always found at the point of fracture. Again, if we rapidly magnetise and demagnetise an iron rod, we have the production of evident heat, due to the constant motion of its molecules.

Maxwell describes an experiment of Beetz, in which an exceedingly small filament of iron was deposited by electrotype, under the influence of a strong magnetic field, in order to arrive at the inherent polarity of comparatively few molecules, and, as its magnetic force was very great, he regards the experiment as conclusive. My own experiments show that we have far less external magnetic force from a solid bar than from a thin tube or flat bar of the same surface exposed to a limited exciting cause. We know that magnetism does not penetrate to a very great depth, and we also know that, if to a thin steel permanent magnet we place another piece unmagnetised, or, better still, a rod of soft iron, its external polarity is greatly reduced, consequently the external evidence of polarity is not a direct measure of the degree of rotation, nor of the total inherent polarity of its mass. We may have a great superficial *external* rotation superposed upon rotations of an opposite nature, as will be seen later; and thus the internal molecules of a magnet often act more or less as an external armature in closing its circle of attractions.

I have stated my belief that the molecule itself possesses its inherent polarity, which, like gravity, is an endowed quality for which we have no more reason to suspect the cause to be elementary electric currents than that elementary currents should be the cause of gravity, chemical affinity, or cohesion, and its polar power of crystallisation, most of which are affected by an electric current. We have a certain analogy between electric currents and magnetism, but not so great as the analogy between the magnetic polarity of a molecule and its other endowed qualities.

Magnetism, like chemical affinity, cohesion, and crystallisation, has its critical points. Faraday discovered that at red-yellow heat iron instantly lost its apparent polar magnetic power, to be as instantly restored at red heat, the critical point varying in iron, steel, &c., and being the lowest in nickel. This would be difficult to explain upon Ampère's theory, as we should have to admit the instant destruction or cessation of the elementary currents, to be again restored at a few degrees less temperature. It would be equally difficult to explain under my view, if it did not belong to a whole class of phenomena due to the possession by the molecules of various endowed qualities, of which chemistry and all our means of research can only teach us their critical points, without attempting to explain why, for instance, iron has a greater affinity for oxygen than gold. We know that it is so; we know that the molecules of all matter are endowed with certain qualities having certain critical points, and I can see no reason for separating their magnetic inherent polarity from their numerous other qualities.

(*To be continued.*)

METERS FOR POWER AND ELECTRICITY[1]

THE subject of this evening's discourse, "Meters for Power and Electricity," is unfortunately, from a lecturer's point of view, one of extreme difficulty; for it is impossible to fully describe any single instrument of the class without diving into technical and mathematical niceties which this audience might well consider more scientific than entertaining. If then in my endeavour to explain these instruments and the purposes which they are intended to fulfil in language as simple and as untechnical as possible, I am not as successful as you have a right to expect, I must ask you to lay some of the blame on my subject and not all on myself.

I shall at once explain what I mean by the term "meter," and I shall take the flow of water in a trough as an illustration of my meaning. If we hang in a trough a weighted board, then when the water flows past it the board will be pushed back; when the current of water is strong the board will be pushed back a long way; when the current is less it will not be pushed so far; when the water runs the other way the board will be pushed the other way. So by observing the position of the board we can tell how strong the current of water is at any time. Now suppose we wish to know, not how strong the current of water is at this time or at that, but how much water altogether has passed through the trough *during* any time, as for instance one hour. Then if we have no better instrument than the weighted board, it will be necessary to observe its

[1] Lecture at the Royal Institution, by Mr. C. Vernon Boys, March 2.

position continuously, to keep an exact record of the corresponding rates at which the water is passing, every minute, or, better, every second, and to add up all the values obtained. This would of course be a very troublesome process. There is another kind of instrument which may be used to measure the flow of the water: a paddle-wheel or screw. When the water is flowing rapidly the wheel will turn rapidly; when slowly, the wheel will turn slowly; and when the water flows the other way the wheel will turn the other way, so that if we observe how fast the wheel is turning we can tell how fast the water is flowing. If now we wish to know how much water altogether has passed through the trough, the number of turns of the wheel, which may be shown by a counter, will at once tell us. There are therefore in the case of water two kinds of instruments, one which measures *at* a time, and the other *during* a time. The term meter should be confined to instruments of the second class only.

As with water so with electricity, there are two kinds of measuring instruments, one, of which the galvanometer may be taken as a type, which shows by the position of a magnet how strong a current of electricity is *at* a time, and the other, which shows how much electricity has passed *during* any time. Of the first, which are well understood, I shall say nothing; the second, the new electric meters and the corresponding meters for power, are what I have to speak of to-night.

It is hardly necessary for me to mention the object of making electric meters. Every one who has had to pay his gas bill once a quarter probably quite appreciates what the electric meters are going to do, and why they are at the present time attracting so much attention. So soon as you have electricity laid on in your houses, as gas and water are laid on now, so soon will a meter of some sort be necessary in order that the companies which supply the electricity may be able to make out their quarterly bills, and refer complaining customers to the faithful indications of their extravagance in the mysterious cupboard in which the meter is placed.

The urgent necessity for a good meter has called such a host of inventors into the field that a complete account of their labours is more than any one could hope to give in an hour. Since I am one of this host I hardly like to pick out those inventions which I consider of value. I cannot describe all, I cannot act as a judge and say these only are worthy of your attention, and I do not think I should be acting fairly if I were to describe my own instruments only and ignore those of every one else. The only way I see out of the difficulty is to speak more particularly about my own work in this direction, and to speak generally on the work of others.

I must now ask you to give your attention for a few minutes to a little abstract geometry. We may represent any changing quantity, as for instance the strength of an electrical current, by a crooked line. For this purpose we must draw a straight line to represent time, and make the distance of each point of the crooked line above the straight line a measure of the strength of the current at the corresponding time. The size of the figure will then measure the quantity of electricity that has passed, for the stronger the current is the taller the figure will be, and the longer it lasts the longer the figure will be, either cause makes both the quantity of electricity and the size of the figure greater and in the same proportion; so the one is a measure of the other. Now it is not an easy thing to measure the size of a figure: the distance round it tells nothing; there is, however, a geometrical method by which its size may be found. Draw another line, with a great steepness where the figure is tall, and with a less steepness where the height is less, and with no steepness or horizontal where the figure has no height. If this is done accurately, the height to which the new line reaches will measure the size of the figure first drawn; for the taller the figure is, the steeper the hill will be; the longer the figure, the longer the hill; either cause makes both the size of the figure and the height of the hill greater, and in the same proportion; so the one is a measure of the other; and so, moreover, is the height of the hill, which can be measured by a scale, a measure of the quantity of electricity that has passed.

The first instrument that I made, which I have called a "cart" integrator, is a machine which, if the lower figure is traced out, will describe the upper. I will trace a circle; the instrument follows the curious bracket-shaped line that I have already made sufficiently black to be seen at a distance, the height of the new line measures the size of the circle, the instrument has squared the circle. This machine is a thing of mainly theoretical interest, my only object in showing it is to explain the means by which I have developed a practical and automatic instrument of which I shall speak presently. The guiding principle in the cart integrator is a little three-wheeled cart, whose front wheel is controlled by the machine. This, of course, is invisible at a distance, and therefore I have here a large front wheel alone. On moving this along the table, any twisting of its direction instantly causes it to deviate from its straight path; now suppose I do not let it deviate, but compel it to go straight, then at once a great strain is put upon the table which is urged the other way. If the table can move it will instantly do so. A table on rollers is inconvenient as an instrument, let us therefore roll it round into a roller, then on moving the wheel along it the roller will turn, and the amount by which it turns will correspond to the height of the second figure drawn by the cart integrator. If, therefore, the wheel is inclined by a magnet under the influence

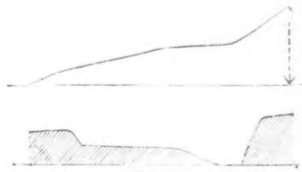

FIG. 1.

of an electric current, or by any other cause, the whole amount of which we wish to know, then the number of turns of the roller will tell us this amount; or to go back to our water analogy, if we had the weighted board to show current strength, and had not the paddle-wheel to show total quantity, we might use the board to incline a disk in contact with a roller, and then drag the roller steadily along by clockwork. The number of turns of the roller would give the quantity of water. Instruments that will thus add up continuously indications at a time, and so find amounts during a time, are called integrators.

The most important application that I have made at present of the integrator described is what I have called an engine-power meter. The instrument is on the table, but as it is far too small to be seen at a distance, I have arranged a large model to illustrate its action. The object of this machine is to measure how much work an engine has done during any time, and show

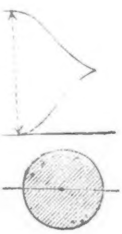

FIG. 2.

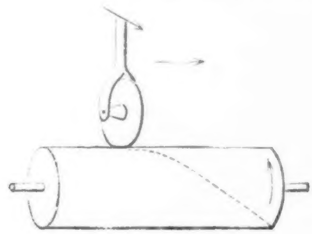

FIG. 3.

the result on a dial, so that a workman may read it off at once without having to make any calculations.

Before I can explain how work is measured, perhaps I had better say a few words about the meaning of the word "work." Work is done when pressure overcomes resistance, producing motion. Neither motion nor pressure alone is work. The two factors, pressure and motion, must occur together. The work done is found by multiplying the pressure by the distance moved. In an engine, steam pushes the piston first one way, then the other, overcomes resistance, and does work. To find this, we must multiply the pressure by the motion at every instant, and add all the products together. This is what the engine-power meter does, and it shows the continuously growing result on a dial. When the piston moves it drags the cylinder along, where the steam presses the wheel is inclined. Neither action alone causes the cylinder to turn, but when they occur together the cylinder turns, and the number of turns registered on a dial shows with mathematical accuracy how much work has been done.

In the steam-engine work is done in an alternating manner,

and it so happens that this alternating action exactly suits the integrator. Suppose, however, that the action whatever it may be, which we wish to estimate is of a continuous kind, such for instance as the continuous passage of an electric current. Then, if by means of any device, we can suitably incline the wheel, so long as we keep pushing the cylinder along, so long will its rotation measure and indicate the result; but there must come a time when the end of the cylinder is reached. If then we drag it back again, instead of going on adding up, it will begin to take off from the result, and the hands on the dial will go backwards, which is clearly wrong. So long as the current continues, so long must the hands on the dial turn in one direction. This effect is obtained in the instrument now on the table, the electric energy meter, in this way. Clockwork causes the cylinder to travel backwards and forwards by means of what is called a

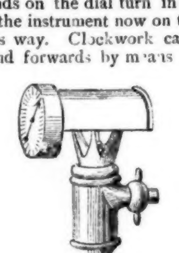

FIG. 4.

mangle motion, but instead of moving always in contact with one wheel, the cylinder goes forward in contact with one, and back in contact with another on its opposite side. In this instrument the inclination of the wheels is effected by an arrangement of coils of wire, the main current passing through two fixed concentric solenoids, and a shunt current through a great length of fine wire on a movable solenoid, hanging in the space between the others. The movable portion has an equal number of turns in opposite directions, and is therefore unaffected by magnets held near it. The effect of this arrangement is that the energy of the current, that is, the quantity multiplied by the force driving it, or the electrical equivalent of mechanical power, is measured by the slope of the wheels, and the amount of work done by the current during any time, by the number of turns of the cylinder, which are registered on a dial. Professors Ayrton and

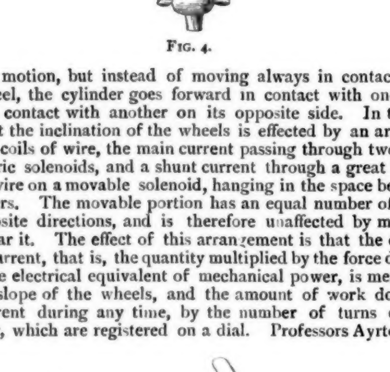

FIG. 5.

Perry have devised an instrument which is intended to show the same thing. They make use of a clock, and cause it to go too fast or too slow by the action of the main on the shunt current; the amount of wrongness of the clock, and not the time shown, is said to measure the work done by the current. This method of measuring the electricity by the work it has done is one which has been proposed to enable the electrical companies to make out their bills.

The other method is to measure the amount of electricity that has passed without regard to the work done. There are three lines on which inventors have worked for this purpose. The first, which has been used in every laboratory ever since electricity has been understood, is the chemical method. When electricity passes through a salt solution, it carries metal with it, and deposits it on the plate by which the electricity leaves the liquid. The amount of metal deposited is a measure of the quantity of electricity. Mr. Sprague and Mr. Edison have adopted this method; but as it is impossible to allow the whole of a strong current to pass through a liquid, the current is divided; a small proportion only is allowed to pass through. Provided that the proportion does not vary, and that the metal never has any motions on its own account, the increase in the weight of one of the metal plates measures the quantity of electricity.

The next method depends on the use of some sort of integrating machine, and this being the most obvious method, has been attempted by a large number of inventors. Any machine of this kind is sure to go, and is sure to indicate something, which will be more nearly a measure of the electricity, as the skill of the inventor is greater.

Meters for electricity of the third class are dynamical in their action, and I believe that what I have called the vibrating meter was the first of its class. It is well known that a current passing round iron makes it magnetic. The force which such a magnet exerts is greater when the current is greater, but it is not simply proportional; if the current is twice or three times as strong, the force is four times or nine times as great, or generally the force is proportional to the square of the current. Again, when a body vibrates under the influence of a controlling force, as a pendulum under the influence of gravity, four times as much force is necessary to make it vibrate twice as fast, and nine times to make it vibrate three times as fast; or generally the square of the number measures the force. I will illustrate this by a model. Here are two sticks nicely balanced on points, and drawn into a middle position by pieces of tape to which weights may be hung. They are identical in every respect. I will now hang a 1 lb. weight to each tape, and let the pieces of wood swing. They

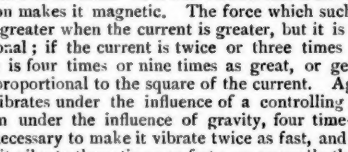

FIG. 6.

keep time together absolutely. I will now put 2 lbs. on one tape. It is clear that the corresponding stick is going faster, but certainly not twice as fast. I will now hang on 4 lbs. One stick is going at exactly twice the pace of the other. To make one go three times as fast, it is obviously useless to put on 3 lbs., for it takes 4 to make it go twice as fast. I will hang on 9 lbs. One now goes exactly three times as fast as the other. I will now put 4 lbs. on the first, and leave the 9 lbs. on the second; the first goes twice while the second goes three times. If instead of a weight we use electromagnetic force to control the vibrations of a body, then twice the current produces four times the force, four times the force produces twice the rate; three times the current produces nine times the force, nine times the force produces three times the rate, and so on; or the rate is directly proportional to the current strength. There is on the table a working meter made on this principle. I allow the current that passes through to pass also through a galvanometer of special construction, so that you can tell by the position of a spot of light on a scale the strength of the current. At the present time there is no current; the light is on the zero of the scale, the meter is at rest. I now allow a current to pass from a battery of the new Faure-Sellon-Volckmar cells which the Storage Company have kindly lent me for this occasion. The light moves through one division on the scale, and the meter has started. I will ask you to observe its rate of vibration. I will now double the current; this is indicated by the light moving to the end of the second division on the scale: the meter vibrates twice as fast. Now the current is three times as strong, now four times, and so on. You will observe that the position of the spot of light and the rate of vibration always correspond. Every vibration of the meter corresponds to a definite quantity of electricity, and causes a hand on a dial to move on one step. By looking at the dial, we can see how many vibrations there have been, and therefore how much electricity has passed. Just as the vibrating sticks in the model in time come to rest, so the vibrating part of the meter would in time do the same, if it were not kept going by an impulse automatically given to it

when required. Also, just as the vibrating sticks can be timed to one another by sliding weights along them, so the vibrating electric meters can be regulated to one another, so that all shall indicate the same value for the same current, by changing the position or weight of the bobs attached to the vibrating arm.

The other meter of this class, Dr. Hopkinson's, depends on the fact that centrifugal force is proportional to the square of the angular velocity. He therefore allows a little motor to drive a shaft faster and faster, until centrifugal force overcomes electromagnetic attraction, when the action of the motor ceases. The number of turns of the motor is a measure of the quantity of electricity that has passed.

I will now pass on to the measurement of power transmitted by belting. The transmission of power by a strap is familiar to every one in a treadle sewing-machine or an ordinary lathe. The driving force depends on the difference in the tightness of the two sides of the belt, and the power transmitted is equal to this difference multiplied by the speed; a power-meter must, therefore, solve this problem—it must subtract the tightness of one side from the tightness of the other side, multiply the difference by the speed at every instant, and add all the products together, continuously representing the growing amount on a dial. I shall now show for the first time an instrument that I have devised, that will do all this in the simplest possible manner. I have here two wheels connected by a driving band of indiarubber, round which I have tied every few inches a piece of white silk ribbon. I shall turn one a little way, and hold the other. The driving force is indicated by a difference of stretching, the pieces of silk are much further apart on the tight side than they are on the loose. I shall now turn the handle and cause the wheels to revolve; the motion of the band is visible to all. The indiarubber is travelling faster on the tight side than on the loose side, nearly twice as fast; this must be so, for as there is less material on the tight side than on the loose, there would be a gradual accumulation of the indiarubber round the driven pulley, if they travelled at the same speed; since there is no accumulation, the tight side must travel the fastest. Now it may be shown mathematically that the difference in the speeds is proportional both to the actual speed and to the driving strain; it is therefore a measure of the power or work being transmitted, and the difference in the distance travelled is a measure of the work done. I have here a working machine which shows directly on a dial the amount of work done; this I will show in action directly. Instead of indiarubber, elastic steel is used. Since the driving-pulley has the velocity of the tight side, and the driven of the loose side of the belt, the difference in the number of their turns, if they are of equal size, will measure the work. This difference I measure by differential gearing which actuates a hand on a dial. I may turn the handle as fast as I please; the index does not move, for no work is being done. I may hold the wheel and produce a great driving strain; again the index remains at rest, for no work is being done. I now turn the handle quickly, and lightly touch the driven wheel with my finger. The resistance, small though it is, has to be overcome; a minute amount of work is being done, the index creeps round gently. I will now put more pressure on my finger, more work is being done, the index is moving faster; whether I increase the speed or the resistance the index turns faster; its rate of motion measures the power, and the distance it has moved, or the number of turns, measures the work done. That this is so I will show by an experiment. I will wind up in front of a scale a 7 lb. weight; the hand has turned one-third round. I will now wind a 28 lb. weight up the same height; the hand has turned four-thirds of a turn. There are other points of a practical nature with regard to this invention which I cannot now describe.

There is one other class of instruments which I have developed of which time will let me say very little. The object of this class of instruments is to divide the speed with which two registrations are being effected, and continuously record the quotient. In the instrument on the table two iron cones are caused to rotate in time with the registration; a magnetised steel reel hangs on below. This reel turns about, and runs up or down the cones until it finds a place at which it can roll at ease. Its position at once indicates the ratio of the speeds which will be efficiency, horse-power per hour, or one thing in terms of another. Just as the integrators are derived from the steering of an ordinary bicycle, so this instrument is derived from the double steering of the "Otto" bicycle.

Though I am afraid that I have not succeeded in the short time at my disposal in making clear all the points on which I have touched, yet I hope that I have done something to remove the very prevalent opinion that meters for power and electricity do not exist.

THE PERMIAN SYSTEM IN RUSSIA [1]

A QUESTION which has during the last few years occupied Russian geologists is whether the upper horizon of the "mottled marls," which were considered by Murchison as Permian, must be still regarded as such, or rather as a member of the Trias—an opinion strongly advocated by several eminent geologists in Russia. The question is a large one, the mottled marls being the most widely-spread member of Murchison's Permian formation in Russia, and covering it almost on the whole of the surface it occupies in Russia in Europe. Were the Triassic origin of the mottled marls an established fact, the whole aspect of a geological map of Russia would be changed, and so it was on the map published in 1870 by a late member of the Academy, M. Helmersen, and on the map of the western slope of the Ural Mountains by Prof. Meller. The question is thus the subject of much controversy, and a whole series of papers is devoted to it in the *Memoirs of the Kazan Society of Naturalists* and elsewhere. The last of this series is a paper by Prof. Stuckenberg, which states the present aspect of the question and enables us to summarise the controversy in its broad features.

Murchison's Permian system covers, as is known, no less than 6600 square miles in eastern Russia, from the province of Archangel in the north to that of Ufa in the south, and from Nijni-Novgorod in the west to Perm and Orenburg in the east; isolated islands of it appear on the surface in the provinces of Astrakhan, Kharkov, and Ekaterinoslav. The evidence itself of the basin where the Permian formation was deposited necessarily implies a great variety of lithological characters, and in fact it includes, besides the dolomitic limestones, a very great variety of marls, clays, sandstones, and conglomerates, the limestones occupying separate basins in the middle parts, whilst the marls, clays, sandstones, and conglomerates have the appearance of coast deposits of the Permian Sea.

In the central parts of the basin (Kazan, Samara), the dolomitic limestones are covered with a thick sheet of mottled marls, with sandstones, conglomerates, clays, and isolated thinner sheets of a tuff-like limestone. This series covers, however, not only the dolomitic limestone but also, as has been said, nearly the whole of the Permian deposits of European Russia, confounding itself with the Permian marls and sandstones, as is, for instance, the case—M. Stuckenberg says—in the provinces of Vyatka, Nijni-Novgorod, Kazan, and Samara. Palæontological evidence, however, is scarce as to the upper mottled marls, so that Murchison himself made the suggestion that they may belong perhaps to a more recent formation; he even proposed to give them on his map a lighter colour than the remainder of the Permian formation.

The mottled marls were considered as Permian until 1855, when Prof. Wagner published a geological map in which he classified them as Triassic. Later on, Marcou, in 1858, and Ludwig, in his "Dias and Trias," in 1859, arrived, independently of Prof. Wagner, at the same conclusion. In 1864 Prof. Barbot de Marny discovered in a sandstone belonging to this group a fragment of an *Equisetites columnaris*, Sternb. (*Calamites arenaceus*, Brongn.), and this discovery, confirming former stratigraphical and lithological considerations, induced the majority of Russian geologists to consider since the mottled marls as a part of the Trias. This view was adopted, as said, by Helmersen and by Prof. Meller. But still, as the mottled marls are very poor in organic remains, and the whole question beset with difficulties, the controversy continued. Murchison found in these marls small *Cytherinæ* and shells like *Cyclas*, together with some remains of fishes and casts of *Mytilus*. Prof. Golovkinsky discovered microscopic remains of crustaceans and some fragments of shells, whilst the late M. Eichwald found remains of *Estheria exigua* and *Beyrichia Pyrrhæ*, in a deposit which M. Stuckenberg considers as belonging to the same group. As to the find by Prof. Wagner of the *Voltzia heterophylla* at Abdi, close by Mamadysh, together with remains of the fishes *Amblypterus Alberti* and *Saurichthys Mougeoti*, M. Stuckenberg

[1] "The Upper Mottled Marls and their Relations to other Members of the Permian System," by A. Stuckenberg. (*Memoirs of the Kazan Societ of Naturalists*, vol. xi. fasc. 2; Kazan, 1882.

doubts, first, the accuracy of the determination, and adds that the *Voltzia* was not found in the mottled marls, but in deposits "parallel to the Permian limestone."

The Zechstein (dolomites, dolomitic limestones, oolite, and gypsum), which reaches a great thickness in the provinces of Kazan and Samara, is a formation which was contemporary with the Permian marls, sandstones, and conglomerates which are widely spread in the provinces of Kazan, Nijni, Vyatka, Perm, Ufa, and Orenburg. On the places where both meet together, the Zechstein penetrates in the shape of thinner sheets into the marls. The copper sandstones of the Ural also would be, according to the same author, contemporary with the Zechstein. These marls and sandstones have a characteristic fauna, and MM. Stuckenberg and Zaitseff discovered in them the following fossils:—*Lingula orientalis*, Golovk.; *Unio umbonatus*, Fisch.; *Unio castor*, Eichw.; *Aucella Hausmanni*, Goldf.; *Estheria exigua*, Eichw.; *Beyrichia Pyrrhæ*, Eichw.; and remains of ganoid fishes and lizards. These fossils are characteristic of the group, but it contains also the Zechstein fossils, *Stenopora columnaris*, Schl., *Schizodus obscurus*, Gein., *Schizodus rossicus*, Vern., *Nucula Beyrichi*, Bron., *Murchisonia subangulata*, Vern., *Gervillia sulcata*, Gein., *Gervillia seratophaga*, Schl., *Hinnites* (*Avicula*) *speluncaria*, Schloth., *Arca Kingiana*, Vern., *Clidophorus Pallasi*, Vern., *Terebratula elongata*, Schl., *Productus Cancrini*, Vern., *Camarophoria Schlotheimi*, Buch., and *Spirifer rugulatus*, Kut. The flora of this series is characterised by many Coniferæ (among others, the *Uhlmannia Bronnii* and *brevifolia*) Noeggerathiæ (*expansa* and *cuneifolia*), ferns, &c. These deposits are thus Permian, and it is worthy of notice that they contain the *Unio umbonatus* and *castor*, the *Estheria exigua*, and the *Beyrichia Pyrrhæ*.

As to the upper mottled marls, which are precisely the subject of the controversy, there was discovered in them but a very few fossils, by MM. Krotoff and Stuckenberg, namely, the four just mentioned (*Unio umbonatus*, *Unio castor*, *Estheria exigua*, and *Beyrichia Pyrrhæ*), on the Volga at Tetushi, and the same in the Government of Vyatka, where the marls contain sheets of limestone; besides, M. Krotoff found Zechstein fossils, as *Arca Kingiana*, in the tuff-like limestone on the Volga, which M. Stuckenberg considers as belonging to the same series. Finally, there was discovered during a boring at Mount Bogdo (Astrakhan), in sandstones and conglomerates, a series of Permian fossils (*Matica minima*, Brown, *Turbonila volgensis*, Golowk,, *Gervillia antiqua*, Mün., *Clidophorus Hollebeni*, *Clidophorus Pallasi*, Vern., *Schizodus rossicus*, Vern., *S. obscurus*, Gein., *Nucula Beyrichi*, Brown, *Leda speluncaria*, Gein., and *Hinnites* (*Avicula*) *speluncaria*, Schloth. M. Stuckenburg, considering the Bogdo sandstones as contemporary with the upper mottled marls, gives to it great weight; but it must be observed that the contemporaneity of the Bogdo marls with the upper mottled marls of the Volga is all but established.

As to the palæontological evidence produced for considering the upper mottled marls as Triassic, namely, those found of the Triassic, *Equisetites columnaris* (*Calamites arenaceus*), *Voltzia heterophylla*, and *Estheria minuta*, M. Stuckenburg considers it unsatisfactory, and points out that the *Voltzia heterophylla* was found rather in Permian deposits; and that Mr. Jones, in his "Monograph of the Fossil Estheriæ," considers the *Estheria minuta* of the Russian mottled marls as different from the *E. minuta*, Brongn., and rather like to the *E. tenella* of Jordan, which last belongs to the Permian and Carboniferous of Western Europe. As to the *Calamites arenaceus*, found by Barbot de Marny, F. Römer, in the last edition of his "Lethea geognostica," remarks that it is too badly preserved to be a decisive evidence. He concludes, therefore, that contrary to the opinion of almost all Russian geologists, that the mottled marls ought to be considered again as Permian. But, as seen from the above summary, it will be much more prudent to conclude that the whole question still remains open for further investigation.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Rede Lecture was delivered on Tuesday in the Senate House by Prof. Huxley, the subject being "The Origin of the Existing Forms of Animal Life, Construction or Evolution?" There were at least eleven hundred persons present, and amongst them nearly all the University dignitaries now in residence.

In the second part of the Natural Sciences Tripos sixteen men and one lady are placed in the first class; of this Mr. Harmer of King's College is distinguished in Zoology and Comparative Anatomy; Mr. Reid of Cavendish College in Human Anatomy; and Mr. Sharrington of Caius College in Physiology.

Prof. Hughes has been elected to a Professorial Fellowship at Clare College.

Messrs. P. Frost, I. Todhunter, and Joseph Wolstenholme are to receive the degree of Doctor in Science.

The Woodwardian Professor dissents strongly from the proposal to place the Sedgwick Museum on the Downing Street site in front of the new museums.

SCIENTIFIC SERIALS

THE *Journal of Anatomy and Physiology* for April, 1883, contains:—A contribution to the study of Spina bifida, encephalocele, and anencephalus, by Prof. Cleland (Plates 11 and 12).—On the minute structure of the palatine nerves of the frog, and the termination of nerves in blood-vessels and glands, by Prof. W. Stirling and J. F. Macdonald (Plate 13).—On the lymphatics of Periosteum, by Drs. George and F. Elizabeth Hoggan (Plate 14).—The brachial plexus of the macaque monkey, and its analogy with that of man, by W. T. Brooks.—A case of primary sarcoma of the pleura, by R. W. Greenish (Plate 15).—Infiltrating carcinoma of the breast, by Dr. G. Barling.—Observations of the diameters of human vertebræ in different regions, by Dr. R. J. Anderson.—On a simple form of Lippman's capillary electrometer useful to physiologists, by Prof. McKendrick.—On so-called sponge-grafting, by Drs. K. Franks and P. S. Abraham (Plate 16).—The valvular action of the larynx, by Drs. T. L. Brunton and T. Cash.—Origin of the internal circumflex from the deep epigastric artery, by Dr. A. Thomson.—On cervical ribs and the so-called bicipital ribs in man in relation to the corresponding structures in the Cetacea, by Prof. Turner.—On a new form of ether microtome, by Dr. Cathcart.—On right-sided sigmoid flexure and rectum, by Dr. E. E. Maddox.—A note to Mr. Haswell's paper on myology of pigeon.

THE *Quarterly Journal of Microscopical Science* for April, 1883, contains:—On the anatomy and development of *Peripatus capensis*, by the late Prof. F. M. Balfour, edited by Professors Moseley and Sedgwick (Plates 13 to 20).—On a morphological variety of *Bacillus anthracis*, by Dr. E. Klein, with notes thereon by Prof. Ray Lankester (Plate 21).—Note on a pink Torula, by H. Marshall Ward (Plate 22).—On double staining nucleated blood corpuscles with anilin dyes, by Dr. V. Harris.—Some recent researches on the continuity of the protoplasm through the walls of vegetable cells, by W. Gardiner.—Review of recent researches on Spermatogenesis, by J. E. Bloomfield.—Note on a minute point in the structure of the spermatozoon of the newt, by G. F. Dowdeswell.—On the existence of Spengel's olfactory organ and of paired genital ducts in the pearly nautilus, by Prof. Ray Lankester and A. G. Bourne.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 12.—"On a New Crinoid from the Southern Sea." By P. Herbert Carpenter, M.A., Assistant Master at Eton College. Communicated by W. B. Carpenter, C.B., M.D., F.R.S.

Among the collections of the late Sir Wyville Thomson, a small *Comatula* has recently been discovered which was dredged by the *Challenger* at a depth of 1800 fathoms in the Southern Sea. Although it is unusually small, the diameter of the calyx being only 2 mm., the characters presented by this form are such as to render it by far the most remarkable among all the types of recent Crinoids, whether stalked or free. The name proposed for it is *Thaumatocrinus renovatus*.

But it is distinguished by four striking peculiarities:—

(1.) The presence of a closed ring of basals upon the exterior of the calyx.

(2.) The persistence of the oral plates of the larva, as in *Hyocrinus* and *Rhizocrinus*.

(3.) The separation of the primary radials by interradials which rest on the basals.

(4.) The presence of an arm-like appendage on the interradial plate of the anal side.

Taking these in order—

(1.) No adult *Comatula*, except the recent *Atelecrinus* and

some little-known fossils, has a closed ring of basals; and even in *Atelecrinus* they are quite small and insignificant.

(2.) In all recent *Comatulæ*, in the *Pentacrinidæ*, and in *Bathycrinus*, the oral plates of the larva become resorbed as maturity is approached. In *Thaumatocrinus*, however, they are retained, as in *Hyocrinus*, *Rhizocrinus*, and *Holopus*, representatives of three different families of Neocrinoids.

(3.) There is no Neocrinoid, either stalked or free, in which the primary radials remain permanently separated as they are in *Thaumatocrinus*, and for a short time after their first appearance in the larva of ordinary Crinoids. The only Palæocrinoids presenting this feature are certain of the *Rhodocrinidæ*, *e.g.* *Reteocrinus*, *Rhodocrinus*, *Thylacocrinus*, &c. In the two latter and in the other genera which have been grouped together with them into the section *Rhodocrinites* there is a single interradial intervening between every two radials, and resting on a basal just as in *Thaumatocrinus*. But in the Lower Silurian *Reteocrinus* the interradial areas contain a large number of minute pieces of irregular form and arrangement.

(4.) It is only, however, in *Reteocrinus* and in the allied genus *Xenocrinus*, Miller, which is also of Lower Silurian age, that an anal appendage similar to that of *Thaumatocrinus* is to be met with.

Of the four distinguishing characters of *Thaumatocrinus*, therefore, one appears in one or perhaps in two genera of *Comatulæ*; another is not to be met with in any *Comatula*, though occurring in certain stalked Crinoids; while the two remaining characters are limited to one family of the Palæocrinoids, one of them being peculiar to one or at most two genera which are confined to the Lower Silurian rocks.

Their reappearance in such a specialised type as a recent *Comatula* is therefore all the more striking.

Geological Society, May 23.—J. W. Hulke, F.R.S., president, in the chair.—Ernest Le Neve Foster and Richard Bullen Newton were elected Fellows of the Society.—The following communications were read:—On the basalt glass (tachylyte) of the Western Isles of Scotland, by Prof. J. W. Judd, F.R.S., Sec.G.S., and G. A. J. Cole, F.G.S. Basalt glass or tachylyte is a rare rock, although very widely distributed. In the Western Isles of Scotland it has, by the authors of the paper, been detected in five localities only, namely, Lamlash (Holy Isle) near Arran, the Beal near Portree in Skye, Gribun and Sorne in Mull, and Screpidale in Raasay. Basalt glass is always found in the Hebrides as a selvage to dykes, though elsewhere it has been described as occurring under other conditions where rapid cooling of basaltic lava has taken place. Some of the varieties of basalt glass in the Hebrides differ from any hitherto described by their high specific gravity (2·8 to 2·9) and by their low percentage of silica (45 to 50). This basalt glass is frequently traversed by numerous joints; it is occasionally finely columnar, and sometimes perlitic in structure. From the acid glasses (obsidian) it is distinguished by its density, its opacity, its magnetic properties, and especially by its easy fusibility, from which the name of tachylyte is derived. By its greater hardness it is readily distinguished from its hydrated forms (palagonite, &c.). In its microscopic characters basalt glass is found to resemble other vitreous rocks; thus it exhibits the porphyritic, the banded and fluidal, the spherulitic, and the perlitic structures. In the gradual transition of this rock into basalt, all the stages of devitrification can be well studied. The difference between these locally developed basalt glasses and the similar materials forming whole lava-streams in the Sandwich Islands was pointed out in the paper, and the causes of this difference were discussed. It was argued that the distinction between tachylyte and hyalomelane, founded on their respective behaviour when treated with acids, must be abandoned, and that these substances must be classed as rocks and not as mineral species; the name basalt glass was adopted as best expressing their relations to ordinary basalt, the term tachylyte being applied to all glasses of basic composition and being used in contradistinction to obsidian.—On a section recently exposed in Baron Hill Park, near Beaumaris, by Prof. T. G. Bonney, F.R.S., Sec.G.S. The author, about three years since, observed some imperfect exposures of a felsitic grit in the immediate vicinity of the normal schists of the district in a road which leads from Beaumaris cemetery to Llandegfan; but last summer had the opportunity, through the courtesy of Sir R. B. Williams, of examining the cuttings made in constructing a new drive, which runs through Baron Hill Park, very near the above outcrops. After tracing the normal schists along the steep scarp of the hill, he came, after an interval of about 60 yards, covered by soil and vegetation, to a massive gray grit consisting of quartz, felspar, and minute fragments of compact felsite, which now and then attain a larger size, being an inch or so across. These grits, which pass occasionally into hard compact mudstones (probably more or less of volcanic origin), can be traced for some 350 yards to the neighbourhood of the above-mentioned road, which is crossed by a bridge; and a short distance on the other side of this is a considerable outcrop of the grit, which in places becomes coarsely conglomeratic, containing large fragments of the reddish quartz-felsite so common on the other side of the straits, in the beds at or below the base of the Cambrian series. The schists appear to dip about 20° E.S.E., the grits about 25° E. The author, after describing the microscopic structure of the various rocks noticed, pointed out that this section, though the junction of the two rocks is probably a faulted one, has an important bearing on the question of the age of the Anglesey schists, micaceous and chloritic. The Survey regards them as altered Cambrian; it has even been suggested that they may be of Bala age; others have regarded them as Pebidian. Now the felsitic grits and conglomerates cannot be newer than the Cambrian conglomerate of the mainland, regarded by Prof. Hughes as the base of the true Cambrian, and are probably older, corresponding with some part of the series between it and the great masses of quartz felsite which are developed near Llyn Padarn and Port Dinorwig, which series lithologically and stratigraphically corresponds with the typical Pebidian of Pembrokeshire. Hence, as the Anglesey schists are in the full sense of the term metamorphic rocks, and the "Pebidian" but slightly altered, this section shows that the former must be much older than the latter, and so be distinctly Archæan.—On the rocks between the quartz-felsite and the Cambrian series in the neighbourhood of Bangor, by Prof. T. G. Bonney, F.R.S., Sec.G.S. This district has already been the subject of papers by the author (*Quart. Journ. Geog. Soc.*, vol. xxxiv. p. 137), and by Prof. Hughes (vol. xxxv. p. 682), who differs from him in restricting the series between the quartz-felsite and Cambrian conglomerate to little more than the bastard slates and green breccias of Bangor mountain. The author has traced on the south-east side of the Bangor-Caernarvon road a well-marked breccia containing fragments of purple slate mixed with volcanic materials, below the above-named Bangor series, for more than a mile. At a lower level he has traced another well-marked breccia, chiefly of volcanic materials, for half a mile; and, lastly, a grit and conglomerate, apparently resting on the quartz-felsite named above, composed of materials derived from it. This has been traced on both sides of the road mentioned above for nearly two miles. For these and for other reasons given in the paper, the author is of opinion that, as he formerly maintained, there is a continuous upward succession on the south-east side of the road, from the quartz-felsite at Brithdir to the Cambrian conglomerate on Bangor mountain. The district on the north-west side of the road is so faulted that he can come to no satisfactory conclusions. The author is in favour of incorporating the above-named quartz-felsites with the overlying beds as one series, corresponding generally with the Pebidian of South Wales; older than the Cambrian, though probably not separated from it by an immense interval of time. An analysis of the Brithdir quartz-felsite by Mr. J. S. Teall, was given, from which it appeared that the rock corresponds very closely with the "devitrified pitchstone" of Lea rock in the Wrekin district, described by Mr. Allport, but differs considerably in composition from those in the Ordovician rocks of North Wales.

EDINBURGH

Royal Society, May 21.—Mr. Robert Gray, vice-president, in the chair.—Obituary notices were read of Sheriff Hallard, Dr. John Muir, Friedrich Wöhler, Sir J. Rose Cormack, M.P., and Dr. Morehead. Mr. John Aitken, in a note on the moon and the weather, observed that the phenomenon of the old moon in the new moon's arms was not always visible in a very clear atmosphere, but that other meteorological conditions seem to be requisite. He suggested that the earthshine might be greatly intensified by a cloud-laden atmosphere to the west of the observer.—Mr. D. B. Dott read a paper on the acids of opium, in which he stated that, contrary to the general opinion, the principal acid in opium, judged by its acidifying powers, is sulphuric and not meconic acid, a considerable portion of the

morphia being always combined with the sulphuric acid.—Prof. Tait gave some results of direct observations of the effect of pressure on the maximum density-point of water. The experiments were a modification of the well-known Hope experiment. A glass vessel of water with a self-registering thermometer at the bottom and a mass of ice at the top was placed inside the water (at 50° F.) of the large hydraulic press. Under a pressure of 3 tons weight per square inch, the thermometer fell to 33° F., whereas at the ordinary atmospheric pressure, but under otherwise similar circumstances, the temperature registered never fell below 41° F.

PARIS

Academy of Sciences, May 21.—M. E. Blanchard, president, in the chair.—Observations of the small planets made with the large meridian of the Paris observatory during the first quarter of the year 1883, communicated by M. Lœwy.—On the critical point of soluble gases, by J. Jamin. The critical point is defined to be the temperature at which a liquid and its saturated vapour have the same density. At and beyond this point the fluid and vapour become fused in one, and all latent heat disappears.—Extract from a memoir on the composition of combustible mineral substances, by M. Boussingault. The proportions are given of the carbon, hydrogen, oxygen, and nitrogen contained in the substances analysed—the bitumen of the Chinese fire-pits and Dead Sea, the Egyptian asphalt, fossil resins, and the anthracites and other coals of South America and France. A method is proposed for eliminating the hydrogen, oxygen, and other impurities from graphite, and thus reducing it, like the diamond, to pure carbon.—The scientific expedition of the *Talisman* to the Atlantic Ocean, by M. Alphonse Milne-Edwards. The *Talisman* sailed from Rochefort on June 1, and will visit the Canaries, Cape Verd Islands, Azores, and intermediate waters.—On the discussion recently raised by the Commission of the Turin Veterinary School, touching the state of the blood of a sheep subjected to carbonic vaccination when examined within a few hours of death and the day after death, by M. Pasteur.—Note by Admiral Pâris accompanying the presentation of his work on the "Naval Museum in the Louvre."—A new method of synthesis for the alkylnitrous acids, by G. Chancel. —On the part respectively played by oxygen and heat in attenuating the carbonic virus by the method of M. Pasteur, by M. A. Chauveau.—On the treatment of the water used in wool-washing, by MM. Delattre. This water yields 4·50 per 100 of a very dry potassium, or a total of 270,000 kilograms, valued at 4300*l.*, on the 6,000,000 kilograms of wool annually washed in France. But from this must be deducted 1000*l.* for the cost of treatment.—On the algebraic functions of Fuchs, by M. H. Poincaré.—On the theory of Euler's integrals, by M. Bourguet.—On the resistance of the atmosphere in very slow oscillatory movements, by M. J. B. Baille.—On the deformation of polarised electrodes, by M. Gouy.—On the electrodynamic interference of alternant currents, by M. A. Oberbeck. —On the sesquisulphuret of phosphorus, by M. Isambert.—On some double salts of lead, by M. G. André.—On the solubility of strychnine in acids, by MM. Hanriot and Blarez.—On a saccharine substance extracted from the lungs and phlegm of consumptive patients, by M. A. G. Pouchet.—On a deposit of quaternary mammals in the neighbourhood of Argenteuil (Seine-et-Oise), by M. Stan. Meunier. Here the author recently discovered remains of the elephant, *Rhinoceros tichorhinus*, cave hyæna, horse, reindeer, and a member of the ox family, apparently *Bison priscus*.—Vegetation of the vine at Calèves, near Nyon, Switzerland, by M. Eugène Risler.

June 4.—M. Blanchard in the chair.—The following papers were read:—On the possibility of increasing in a great measure the precision of the observations of the eclipses of Jupiter's satellites, by A. Cornu.—On the solubility of sulphide of copper in alkaline sulphomolybdates, by M. Debray.—On the solution of certain problems of cosmography by means of graphic tables, by MM. Lalanne and Ed. Collignon.—M. A. Caligny presented to the Academy his work entitled: "Theoretical and Experimental Researches concerning the Oscillations of Water, and the Hydraulic Machines with Oscillating Liquid Columns."—On recent scientific results obtained regarding the etiology of and preventatives from cholera, by A. Fauvel.—Researches on typhoid fever in Paris during the period October 19, 1882, to May 15 a.c., by M. de Pietra-Santa.—On an apparatus for obtaining low temperatures which can be graduated at pleasure, by P. Gibier.—On the hyposulphides of phosphorus, by M. Isambert.—On the sesquisulphide of phosphorus, by G. Lemoine.—Reply to M. le Goarant de Tromelin regarding the electric log, by M. Fleuriais. —On glass-blowing by means of mechanically-compressed air, by M. Appert.—On the observations of Brooks-Swift comet (*a* 1883) made at Paris Observatory, by G. Bigourdan.—On the development of the perturbating function, by B. Baillaud.—On the uniform functions of two analytical points which are left invariable by an infinity of rational transformations, by M. Appell. —On uniform functions, by J. Farkas.—On a correction of the stereotyped formula in the preface of Callet, by M. Em. Barbier.—Practical rules for substituting certain closed curves for a given arc, by H. Léauté.—On passive mechanical power, interior resistance, and other points relating to electro-magnetism, by G. Cabanellas.—On the freezing point of acid solutions, by F. M. Raoult.—Comparison of the evaporation of fresh water and sea water at different degrees of concentration; consequences relating to a sea in the interior of Algeria, by M. Dieulafait.—Notes on the preceding communication, by M. Jamin.—Thermical studies on the solution of hydrofluoric acid in water, by M. Guntz.—On the transformation of glycol into glycolic acid, by M. de Forcrand. —Researches on the production of crystallised borates in the wet way, by A. Ditte.—On the reaction of sulphide of lead upon metallic chlorides, by A. Levallois.—On the burning of gypsum, by H. le Chatelier.—On an acid resulting from the oxidation of strychnia, by M. Hanriot.—On the life capacity of the monstrous embryos of chickens, by M. Dareste.—On the artificial production of the inversion of the viscera or "heterotaxy" in chicken embryos, by MM. Hermann Fol and St. Warynski.—Observations on blastogenesis and alternating generation in Salpa and Pyrosoma, by L. Joliet.—On the localisation of virus in wounds and on the mode of its dissemination in the organism, by G. Colin.—Experimental researches on the lesion of the spinal marrow, determined by the hemisection of that organ, by E. A. Homén.—On the mechanical organisation of the pollen-grain, by J. Vesque.—Note on the life and work of Prof. da Costa Simoïdes of Coimbra, by Eduardo Abren.—On a method of utilising sewage water, by MM. Delattre and Pinot.

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